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A Revision of the Bornean Species of the Ant Genus *Pheidole* (Insecta: Hymenoptera: Formicidae: Myrmicinae)

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***Pheidole upeneci* Forel**

The Japan Society of Tropical Ecology 日本熱帯生態学会

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A Revision of the Bornean Species of the Ant Genus *Pheidole* (Insecta: Hymenoptera: Formicidae: Myrmicinae)

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ABSTRACT The genus *Pheidole* is one of the dominant ant taxa in forest habitats in world tropics. This taxonomic revision treats the *Pheidole* fauna of Borneo, the third-largest island in the world, which is situated in the Oriental tropics. Fifty-two species, of which 23 are new species described herein, are recognised from Borneo: *P. acantha* sp. nov., *P. aglae* Forel, *P. angulicollis* sp. nov., *P. annexus* sp. nov., *P. aristotelis* Forel, *P. bugi* Wheeler, *P. butteli* Forel, *P. cariniceps* sp. nov., *P. cingulata* (Fr. Smith), *P. clypeocornis* sp. nov., *P. comata* Fr. Smith, *P. deltea* sp. nov., *P. elisae* Emery, *P. fantasia* Chapman, *P. fervens* Fr. Smith, *P. ghigii* Emery, *P. gombakensis* sp. nov., *P. havilandi* Forel, *P. hortensis* Forel, *P. huberi* Forel, *P. inornata* sp. nov., *P. kikutai* sp. nov., *P. lokitae* Forel, *P. longipes* (Fr. Smith), *P. lucioccipitalis* sp. nov., *P. manukana* sp. nov., *P. megacephala* (Fabricius), *P. merimbun* sp. nov., *P. modiglianii* Emery, *P. montana* Eguchi, *P. orophila* sp. nov., *P. parvicorpus* sp. nov., *P. plagiaria* Fr. Smith, *P. planidorsum* sp. nov., *P. plinii* Forel, *P. poringensis* sp. nov., *P. quadrensis* Forel, *P. quadricuspis* Emery, *P. quinata* Eguchi, *P. rabo* Forel, *P. retivertex* sp. nov., *P. rugifera* sp. nov., *P. sabahna* Eguchi, *P. sarawakana* Forel, *P. sauberi* Forel, *P. sayapensis* sp. nov., *P. spinicornis* sp. nov., *P. submonticola* sp. nov., *P. tawauensis* sp. nov., *P. tenebricosa* sp. nov., *P. tjibodana* Forel and *P. upeneci* Forel. Lectotypes are designated for *P. bugi*, *P. fantasia*, *P. javana* var. *desucta* Wheeler and *P. rinae* var. *mala* Forel. *P. elisae* var. *nenia* Forel, 1913 is herein synonymised with *P. elisae* Emery, 1900, and *P. javana* var. *desucta* Wheeler, 1929 with *P. fervens* Fr. Smith, 1858. Keys to the Bornean species are given for majors, minors, and majors and minors combined. Distributional and ecological data are given for most species. Biogeography of the Indo-Chinese and Indo-Malayan *Pheidole* is briefly discussed.

Key words: Insecta / Hymenoptera / Formicidae / *Pheidole* / Borneo / Indo-Malayan / Indo-Chinese / taxonomy / biogeography / new species / lectotype / new synonymy

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The ant genus *Pheidole* was established for *Atta providens* Sykes by Westwood (1839), and is one of the largest genera in the family Formicidae. Up to the end of 1993, 545 species have been described in the world (Bolton, 1995a), while Brown (2000) estimated the total number of species to be 910. *Pheidole* is included in the tribe Pheidolini, along with the genera *Aphaenogaster*, *Chimaeridris*, *Goniomma*, *Huberia*, *Kartidris*, *Lophomyrmex*, *Messor*, *Ocymyrmex*, *Oxyopomyrmex* and *Paraphaenogaster* (fossil taxon) (Bolton, 1995b). The genus is distributed worldwide in the tropics and warm temperate regions (Brown, 2000, Table 5.1). The complicated history of taxonomic treatments of the genus-group taxa associated with *Pheidole* was summarised in Bolton (1995b). Brown (2000) pointed out that probably the largest bloc of unrevised species is the genus *Pheidole*, of which the Nearctic species have been partly revised by Gregg (1959). In the Oriental region *Pheidole* faunas have been hitherto studied in several areas: Japan (Ogata, 1982), Nansei Islands, Japan (Terayama, 1999), China (Wheeler, 1928, 1930; Wu & Wang, 1995; Xu *et al.*, 1998), Taiwan (Forel, 1912a; Wheeler, 1909), Burma (Bingham, 1903), Philippines (Baltazar, 1966), Singapore (Viehmeyer, 1916), Borneo (Wheeler, 1919), Sumatra (Forel, 1913; Crawley, 1924), Simeulue (Forel, 1915), Java (Forel, 1905, 1913), and India and Ceylon (Forel, 1902; Bingham, 1903). Most of them were, however, based on limited collections, and / or incomprehensive as revisions of regional faunas (with few exceptions, *e.g.*, Ogata, 1982).

In his revision of Bornean ants Wheeler (1919) listed and described only eight species of *Pheidole*: *P. megacephala* (Fabricius), *P. javana* Mayr (synonymised with *P. fervens* Fr. Smith in Wilson & Taylor, 1967), *P. bugi* Wheeler, *P. aristotelis* Forel, *P. comata* Fr. Smith, *P. havilandi* Forel, *P. sauberi* subsp. *sarawakana* Forel (raised to species: Eguchi, 2001), *Ischnomyrmex longipes* (Fr. Smith) (treated as *P. longipes* in Bolton, 1995b). I have so far recognised 52 species from Borneo, mainly based on the material from Sabah, Sarawak and Brunei. Through my careful examination of type materials of most of the species and subspecies of *Pheidole* originally described from the Indo-Malayan subregion, and also of some of the forms described from the Indo-Chinese subregion, I have found 23 species to be new to science.

In this study I have attempted to revise Bornean *Pheidole*, although material from Kalimantan (Indonesian Borneo) is still quite limited. Firstly, I present a generic diagnosis and keys to Bornean species excluding *P. cingulata* (Fr. Smith). This species was described from Borneo, but the original description was brief and rough, and according to B. Bolton (in litt., 2000) "the types of *P. cingulata* are not here [BMNH], not at Oxford, and are presumed lost". For previously known species

identifications have been based on comparison with the type materials in most cases, and redescriptions are given for Bornean populations. Biological notes are given as far as possible. Finally biogeographical notes on the Indo-Chinese and Indo-Malayan *Pheidole* faunas are given. External morphological characters of the worker (both the major and minor workers) examined under a dissecting binocular microscope are mainly used in the species descriptions. My recognition of species is guided by the principle that the most powerful evidence for the existence of more than one species is the sympatric occurrence of morphologically and / or biologically discrete forms. Therefore the species enumerated below are expected to be real biological species except in cases where specimens are available from only a few localities.

The genus *Pheidole* is one of the prevalent ground-dwelling genera (in both species-richness and abundance) in world tropics, including, of course, the Indo-Malayan subregion (Brühl *et al.*, 1998, Table 2; Ito *et al.*, 2001; Yamane, 1997; Yamane *et al.*, 1996; Ward, 2000), and the species appear to play important roles in the forest ecosystem as omnivores, scavengers and predators of small invertebrates. However, difficulties in sorting and identification at species level have hindered us from accumulating any kind of biological information on most species. As pointed out by Ito *et al.* (2001), we are often not confident of the association of minor and major workers in the samples collected using Winkler bags, pitfall traps, etc. that are often used to assess biodiversity of ant. Therefore, the present revision of the Bornean *Pheidole* including information on the combination of the subcastes may contribute to various fields of biology especially those concerning biodiversity. Biological information arising from such biological fields will in turn improve the recognition of *Pheidole* species in line with biological species concept. In other words this revision presents a starting point from which a biologically acceptable taxonomy of *Pheidole* may become established.

MATERIALS AND METHODS

Environments of Main Collection Sites

Kinabalu Park Headquarters area Mt. Kinabalu (Low's Peak: 6°05'N 116°33'E, 4101 m alt.) lies northeast of Kota Kinabalu, Sabah. The area around the Kinabalu Park Headquarters (1500-1800 m alt.) is covered with mixed oak forests (20-30 m in height) with tropical elements (Dipterocarpaceae, Musaceae, Palmae, Araceae, etc.) (Kobayashi & Hotta, 1978), and annual rainfall and mean annual temperature estimated at 1560 m alt. are 2714 mm and 18.9°C, respectively (Aiba & Kitayama, 1999). The substrate of the area is formed of non-ultrabasic Tertiary (40 mya) sedimentary rocks typically characterised by shale, slate, siltstone and thin sandstone beds (Trusmadi Formation) (Choi, 1996). Collections were made mainly by Toru Kikuta and me from 1500 to 1800 m alt.

Poring This area (6°03'N 116°42'E, inside the Kinabalu Park) lies east of Mt. Kinabalu, and I made collections in lowland-type to hill-type dipterocarp forests (500-600 m alt.) which provide leafy forest floor and thick leaf litter, damp soil, fallen-down tree trunks and moist debris of flaky rocks (Kobayashi & Hotta, 1978). Collections were also made by Toru Kikuta at ca. 600 m, 900 m and 1200 m alt., and by Carsten Brühl along East Ridge from 500 to 1930 m alt.

Sayap Kinabalu (= Sayap Substation area of the Kinabalu Park) This area (6°12'N 116°33'E, ca. 1000 m alt.) lies north of Mt. Kinabalu, and in a transitional zone between lowland forest and lower

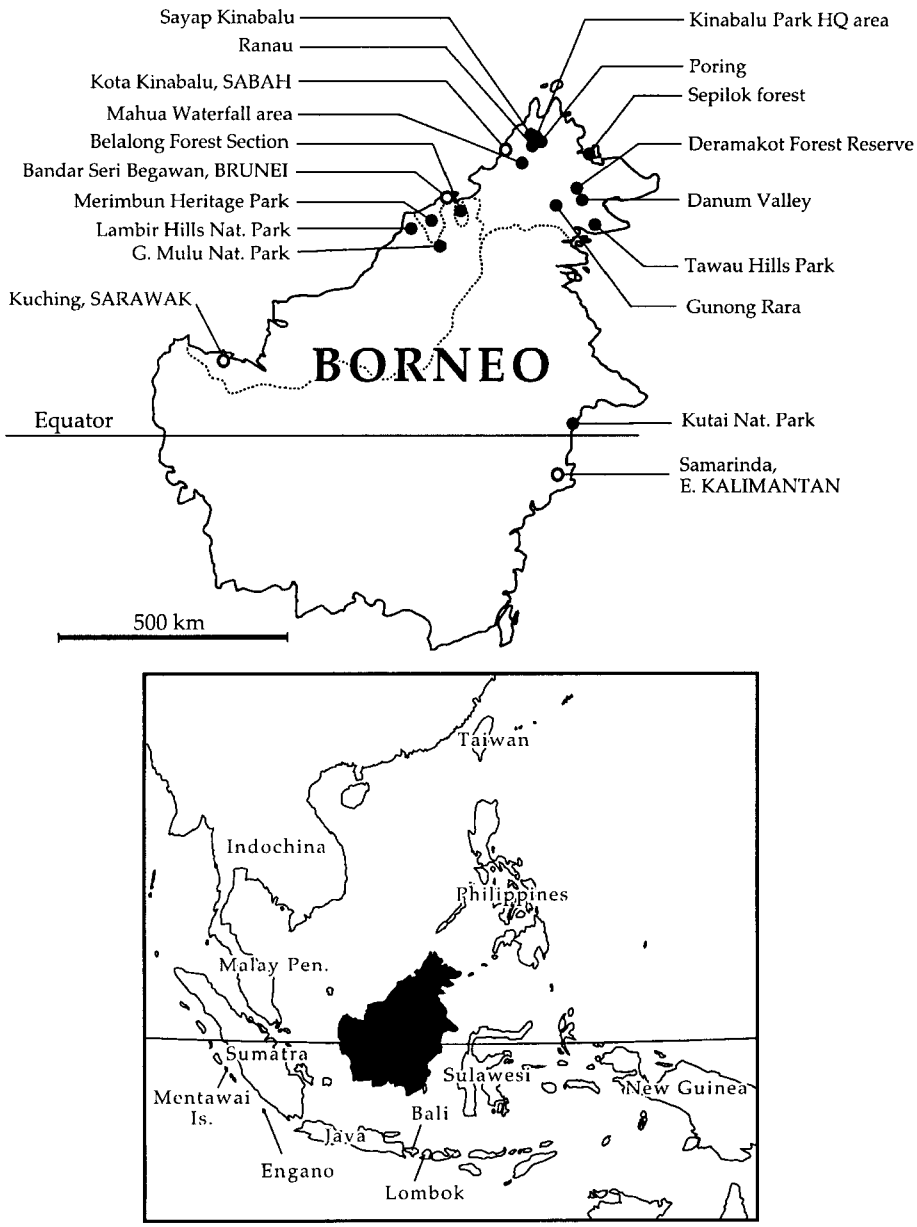

Fig. 1. Map of main collection sites in Borneo.

montane forest (Kikuta *et al.*, 1997; see also Kobayashi & Hotta, 1978). The main trail is relatively wide, probably providing forest edge habitats, from which smaller trails extend into the forest. Collection was made along this trail system close to the substation headquarters.

Mahua Waterfall area Taman Banjaran Crocker (Crocker Range National Park) is a forest-covered mountain range which stretches in a southwesterly direction from Mt. Kinabalu toward Sabah-Sarawak border. The peaks of the range are about 30 km from the coastline and rise to between

1200 and 1800 m alt. The natural vegetation of the lower parts of the Crocker Range is hill dipterocarp forest, and that of the upper zones is rich in oaks, chestnuts and conifers. The highest ridges bear thick mossy forests (WWF Malaysia (ed.), 1998). Mahua Waterfall area is located near downtown of Tambunan, Sabah, and in the northern part of the national park. Collections were made between 1000 and 1100 m alt. along the main trail. The area is probably in a transitional zone between hill-type tropical rain forest and lower montane oak forest (see Kobayashi & Hotta, 1978), and the forest floor along the trail is covered with abundant herbs.

Sepilok Forest (= Kabili-Sepilok Forest Reserve) The Kabili-Sepilok Forest Reserve is located 24 km by road from downtown of Sandakan, Sabah, and occupies an area of 43 km^2. The reserve is covered almost entirely by lowland forests predominated by the family Dipterocarpaceae (WWF Malaysia (ed.), 1998). Collections were made in the reserve and an artificial vegetation around the Rainforest Interpretation Centre.

Deramakot Forest Reserve This forest reserve is located about 50 km south of downtown of Telupid, and extends over an area of 551 km^2 between 117°20'E and 117°42'E, and 5°19'N and 5°20'N. The forests of Deramakot occupy parts of a basin between 20 and 100 m alt., formed by five rivers which all drain into the Kinabatangan River which marks the reserve southern border. The reserve consists of mixed dipterocarp lowland forest of the *Parashorea tomentella* / *Eusideroxylon zwagleri* type which covers much of the Sandakan area, but due to the past management from 1956 the forest structure became extremely heterogeneous with a wide range of structural features, from open gaps to dense stands (Carsten Brühl, 2000, pers. com.). Collections were made by Carsten Brühl in DFR (secondary forest, one of the 134 compartments within the Deramakot forest reserve) in 1998 and 1999.

Danum Valley Field Centre area Danum Valley Conservation area is situated in eastern Sabah at the upper reaches of the Segama River, approximately 70 km from the coast, and comprises 438 km^2 of tropical lowland evergreen dipterocarp forest. Annual rainfall and mean annual temperature at Danum Valley Field Centre (4°58'N 117°48'E) are 2822 mm and 26.7°C, respectively (Chung & Maryati Mohamed, 1993). Collections were made along the trail system around the Headquarters (ca. 200 m alt.).

Gunong Rara This area (4°58'N 117°08'E, ca. 250 m alt.) is located in central Sabah. Logging was performed in recent years, and my collection was made in the front line of the logging in early December, 1996 and late February, 1997.

Tawau Hills Park This park which covers an area of nearly 280 km^2 is located in southeastern Sabah, about 20 km north of downtown of Tawau. The terrain is quite rugged and hilly, with altitudes ranging from 30 to 1310 m. The vegetation is of a lowland rainforest dominated by dipterocarp species (Siraj Omar & Jamili Nais, 1995). Sixty percents of the area are covered with primary rainforest and the remaining 40 % are secondary (logged-over) dipterocarp forest (Malim *et al.*, 1995). Collections were made in a lowland forest (including forest edges and watersides) and open land very close to the park headquarters.

Belalong Forest Section This area lies within the Batu Apoi Forest Reserve, Temburong, Brunei Darussalam, and extends over approximately 50 km^2, from the river junction of Sungai Belalong and Sg. Temburong in the north to the summit of Bukit Belalong (913 m) in the south (Earl of Cranbrook & Edwards, 1994). Collection was made mainly along the Ashton trail from Kuala Belalong Field

Studies Centre (near the river junction, 4°32'N 115°09'E) to an altitude of ca. 400 m. The trail extends into mixed dipterocarp forests with dense uneven canopies and large crowns (see maps on pp. 8 and 105 in Earl of Cranbrook & Edwards, 1994). Additional collections were also made along a trail toward the canopy walkway.

Tasek Merimbun Nature Reserve This reserve is located in Tutong District, Brunei Darussalam, and covers an area of 78 km^2, having a shallow lake, Tasek Merimbun. Most of the area consists of old secondary forests, and primary forests remain only in certain areas (National Museum, Singapore (ed.), 1988). The flora is of dipterocarp, mixed dipterocarp and peat swamp forests (Marina Wong, 1999, pers. com.). Collections were made in mixed dipterocarp and peat swamp forests around the lake.

Lambir Hills National Park This park is located 24 km south of the downtown of Miri, Sarawak, Malaysia, and covers an area of 70 km^2. The terrain is rugged in the central, highest portion of the park, Bukit Lambir (465 m), but much more gentle in other parts. Extremely species-rich lowland rain forest covers most of the park (Hazebroek & Abang Kashim bin Abang Morshidi, 2000). Collections were mainly made in a lowland mixed dipterocarp forest on the sandstone and shale substrate (Lambir Formation) from 100 to 200 m alt. close to the headquarters (see Figs. 90, 94 and 95 in Hazebroek & Abang Kashim bin Abang Morshidi, 2000).

Abbreviations in the Collection Data

- The names of some of the collectors are abbreviated as follows: CB (Carsten Brühl), FI (Fuminori Ito), KE (Katsuyuki Eguchi), MK (Minoru Kawamura), HO (Hirofumi Ôkido), SKY (Seiki Yamane), and TK (Toru Kikuta).
- Colonies collected by KE are given a colony code, like Eg99-BOR-001 where 99 means 1999. In the case where an Eg-colony code is applied to a colony collected by another person, the name of the collector always follows.
- Colonies collected by FI are given a colony code like FI92MG-001 or FI99-001 where 92 and 99 denote 1992 and 1999, respectively.
- Codes such as 528, 6XII1006-S5-2, 06Q33B4, etc. pertain to the colonies collected by T. Kikuta who conducted extensive samplings of ants from rotting twigs and logs on forest floor in Mt. Kinabalu, Sabah during 1996-1998.
- Colonies collected by SKY are given a colony code like SB99-SKY-01 where SB denotes Sabah and 99 is abbreviation of 1999.
- Colonies collected by HO are given a colony code like MA00-HO-01 where MA denotes Malaysia and 00 is abbreviation of 2000.
- Colonies collected by MK are given a colony code like 10/6a, D11 or 153.
- Litter and soil samples in an excursion to Tawau and Sayap Kinabalu (Borneo) in 1996 were coded like LS-1 and Soil-1 (or S-1), respectively.
- GC denotes general collecting.
- Specimens with an indication of SNS (Sumatra Nature Study) were collected by SKY and Soichi Yamane in West Sumatra in 1985.
- Specimens with an indication of KUKE (Kagoshima University Krakatau Expedition) were collected

by SKY mainly on the Krakatau Islands, Indonesia in 1982.

Specimen Depositories and their Abbreviations

BMNH: the Natural History Museum, Cromwell Road, London SW7 5BD, England.
FRCK: Forest Research Centre, Batu 6 Jalan Penrissen, 93250 Kuching, Sarawak, Malaysia.
FRIM: Forest Research Institute Malaysia, Kepong, 52109 Kuala Lumpur, Malaysia.
MBD: Museum Brunei, Jalan Kota Batu BD 1510, Brunei Darussalam.
MCSN: Museo Civico di Storia Naturale "Giacomo Doria", Via Brigata Liguria, 9, I-16121 Genova, Italy.
MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts 02138, USA.
MHNG: Muséum d'Histoire Naturelle, Case Postale 6434, CH-1211 Genève 6, Swisse.
MNHA: Museum of Nature and Human Activities, Hyogo, 6-chome, Yayoigaoka, Sanda, Hyogo, 669-1546 Japan.
MSNM: Museo Civico di Storia Naturale, corso Venezia, 55, 20121 Milano, Italy.
MZLS: Musée Zoologique, Place Riponne 6, Case Postale 448, CH-1000 Lausanne 17, Swisse.
NHMW: Naturhistorisches Museum Wien, Postfach 417, Burgring 7, 1040 Wien, Austria.
UMS: Universiti Malaysia Sabah, Locked Bag No. 2073, 88999 Kota Kinabalu, Sabah, Malaysia.
ZMHB: Zoologisches Museum an der Humboldt-Universität zu Berlin, 10115 Berlin, Invalidenstraße 43, Deutschland.

Measuring Methods and Terminology

The following measurements and indices are given for the major and minor workers, unless otherwise stated.

TL: Total length. Length of out-stretched specimens from mandibular apex to gastral tip.
HL: Maximal length of head measured in a straight line from the mid-point of anterior margin of clypeus to the mid-point of posterior margin of head in the minor. In the major where anterior margin of clypeus and posterior margin of head are concave the measurement is taken from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (as shown in Fig. 2A).
HW: Maximal width of head excluding eyes.
SL: Length of antennal scape, excluding the basal condylar bulb.
AL: Length of alitrunk, measured from anterior margin of promesonotum to posterior margin of propodeal lobe. This measurement is given for the minor alone (anterior margin of alitrunk of the major is hidden by head and invisible).
FL: Length of hind femur.
CI: Cephalic index=HW/HL×100.
SI: Scape index=SL/HW×100.
FI: Hind femur index=FL/HW×100.

Terms of relative position and morphological terms follow those in Bolton (1994), (cf. Fig. 2).

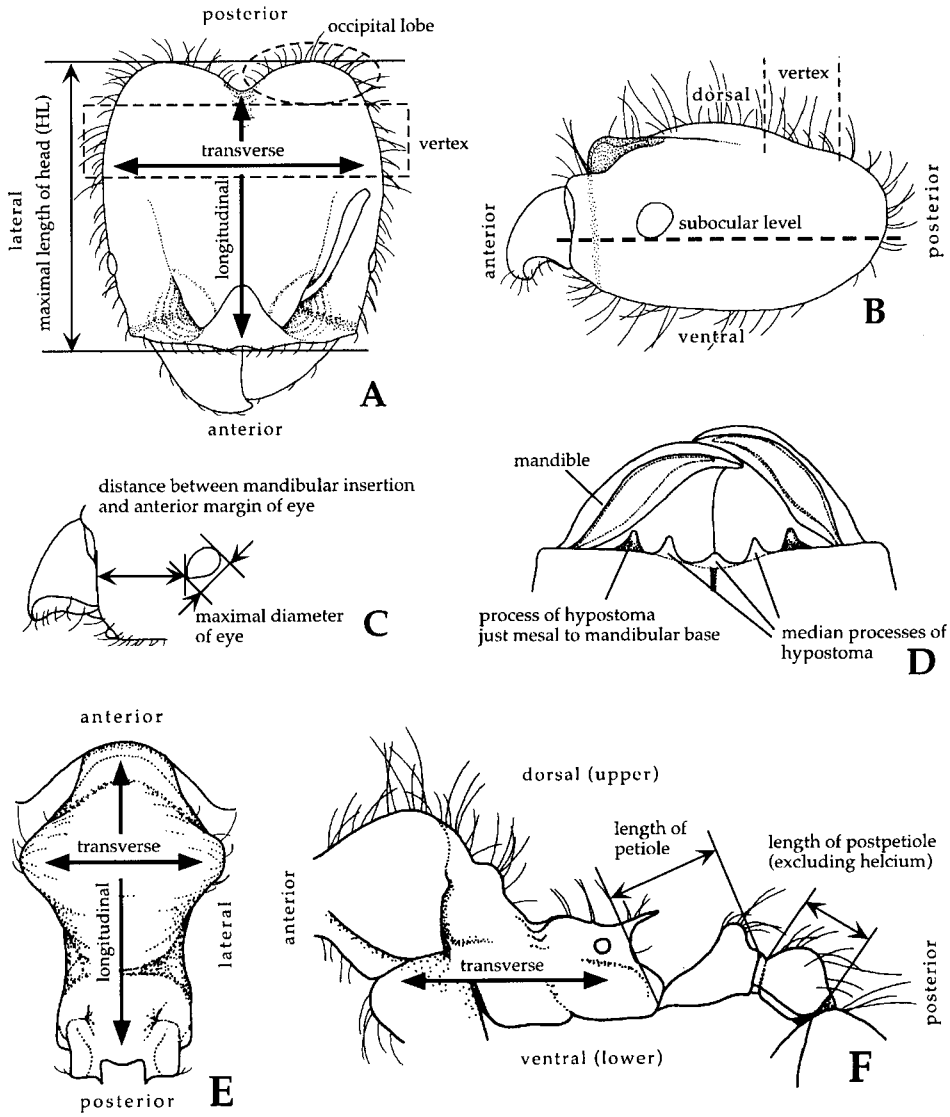

Fig. 2. Measuring points, terms of relative position, and some morphological terms. A, head of the major worker in full-face view; B, same in profile; C, anterior part of head of the major worker in profile; D, same in ventral view; E, alitrunk in dorsal view; F, alitrunk and waist in profile.

TAXONOMY

Generic Diagnosis

Indo-Chinese and Indo-Malayan species of this genus can be distinguished from those of the other myrmicine genera by a combination of the following characteristics.

- Worker dimorphic, but rarely "polymorphic" (the major showing a relatively wide range in size, *e.g.*, in *Pheidole smythiesii* Forel).
- Antenna 12-segmented; antennal club 3-segmented, but rarely 4-segmented (*P. smythiesii*, *P. bluntschlii* Forel, *P. gatesi* (Wheeler) and *P. sinica* (Wu & Wang)), 5-segmented (*P. quinata* Eguchi and *P. sabahna* Eguchi), or inconspicuous (*P. comata* Fr. Smith, *P. longipes* Fr. Smith and *P. montana* Eguchi).
- Palp formula (PF: maxillary palp and labial palp) 2, 2 or 3, 2 (Bolton, 1994). PF of the minor of the following species is confirmed as 2, 2 in the present study: *P. acantha* sp. nov., *P. aglae*, *P. annexus* sp. nov., *P. aristotelis*, *P. cariniceps* sp. nov., *P. clypeocornis* sp. nov., *P. comata*, *P. elisae*, *P. hortensis*, *P. inornata* sp. nov., *P. longipes*, *P. lucioccipitalis* sp. nov., *P. megacephala*, *P. modiglianii*, *P. montana*, *P. plagiaria*, *P. planidorsum* sp. nov., *P. quadrensis*, *P. quadricuspis*, *P. quinata*, *P. rabo*, *P. retivertex* sp. nov., *P. sabahna*, *P. sauberi*, *P. sayapensis* sp. nov., *P. tenebricosa* sp. nov. and *P. tjibodana*.
- Promesonotum forming a dome which is higher than the level of dorsal surface of propodeum; its posterior declivity toward metanotal groove sometimes with a prominence.
- Propodeal spine present, but variable in size and shape.
- Petiole in profile cuneiform, and usually with a distinct node.

The following characteristics are seen only in the major.

- Posterior corner of head well developed and forming occipital lobe (Fig. 2A).
- Mandible massive; masticatory margin of mandible edentate excluding apical and preapical teeth, and 1-2 denticles in front of basal angle (the margin rarely without the denticles).
- Hypostoma (anteriormost region of venter of cranium) always bearing a large or reduced process just mesal to each mandibular base, and often bearing 1-3 median processes (Fig. 2D).
- Articulation between head and alitrunk located on posteroventral face of head.

Keys to Species of Bornean *Pheidole*

Because the major of *P. gombakensis* sp. nov. has not been collected from Borneo, the major from Ulu Gombak, southern Malay Peninsula are used for making the keys "A" and "C".

A. Majors

1. Antenna with 3-segmented club 6
- Antenna with 5-segmented club (Figs. 40C, 44C), or without conspicuous club 2

2 (1). Apical five antennal segments forming conspicuous club; hypostoma bearing three low median processes; subpetiolar process low, with ventral margin carinate (Fig. 40E, 44E)..... 3
- Antenna lacking conspicuous club; hypostoma lacking distinct median processes; subpetiolar process absent (Figs. 12C, 25C, 31C)..... 4
3 (2). Head in profile distinctly impressed on vertex (Fig. 40B)..... *P. quinata* Eguchi [p.100]
- Head in profile not, or only slightly, impressed on vertex (Fig. 44B)..... *P. sabahna* Eguchi [p.108]
4 (2). Dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing 10-20 standing hairs (Fig. 31C); propodeal spine at least 3.5 times as long as diameter of propodeal spiracle; body light brown to reddish brown..... *P. montana* Eguchi [p.83]
- Dorsum of promesonotal dome in front of the prominence on posterior declivity bearing less than 10 standing hairs in *P. longipes* (Fig. 25C), or ca. 20 standing hairs in *P. comata* Fr. Smith (Fig. 12C); propodeal spine usually at most 2.5 times as long as diameter of propodeal spiracle; body reddish brown to dark brown..... 5
5 (4). Head densely bearing standing hairs over the surface (Fig. 12A, B); lateral face of occipital lobe distinctly rugose; dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing ca. 20 standing hairs (Fig. 12C)..... *P. comata* Fr. Smith [p.45]
- Head with sparse standing hairs only on frons and vertex (Fig. 25A, B); lateral face of occipital lobe weakly and finely rugose, or almost smooth and shining; dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing at most 10 standing hairs (Fig. 25C)..... *P. longipes* Fr. Smith [p.71]
6 (1). Promesonotum armed with a pair of long and pointed spines (Fig. 38D, E); hypostoma always bearing a pair of stout median processes (Fig. 38C)..... 7
- Promesonotum unarmed, or each dorsolateral portion of promesonotum produced outward (*e.g.*, *P. aristotelis* (Fig. 7D)), but never armed with long and pointed spines; hypostoma bearing 0-3 median processes..... 11
7 (6). Gaster smooth and shining over the surface, or only anterior part of first gastral tergite near its articulation with postpetiole weakly punctured; petiolar node in profile acute at apex (Fig. 3C)..... *P. acantha* sp. nov. [p.25]
- At least first gastral tergite punctured or rugoso-punctured and dull over the surface; petiolar node in profile blunt at apex (Figs. 24C, 38E, 39C, 48C)..... 8
8 (7). Propodeal spine digitiform and blunt apically (Fig. 39C); alitrunk sparsely covered with relatively short standing hairs (Fig. 39C)..... *P. quadricuspis* Emery [p.98]
- Propodeal spine horn-like or elongate-triangular, pointed apically (Figs. 24C, 38E, 48C); alitrunk covered with relatively long standing hairs (Figs. 24C, 38E, 48C)..... 9
9 (8). Propodeal spine elongate-triangular with broad base (Fig. 38E)..... *P. quadrensis* Forel [p.96]
- Propodeal spine horn-like with narrow base (Figs. 24C, 48C)..... 10
10 (9). Body larger (*e.g.*, HW 2.79-2.91 mm); subpetiolar process completely absent (Fig. 24C)..... *P. lokitae* Forel [p.69]
- Body smaller (*e.g.*, HW 1.73-2.12 mm); petiole with very low subpetiolar process (Figs. 48C)..... *P. spinicornis* sp. nov. [p.116]
11 (6). Legs from apex of femur to apex of tarsus ivory-white, contrasted with remainder of femur which is dark brown..... *P. fantasia* Chapman [p.51]

- Legs almost unicolored 12

12 (11). Frontal lobe extremely developed, extending beyond anterior margin of clypeus (Fig. 53A, B) ..... *P. upeneci* Forel [p.125]

- Frontal lobe sometimes developed, but never extending beyond anterior margin of clypeus (Figs. 50B, 52B) 13

13 (12). Eye consisting of 5-7 ommatidia (Fig. 33B); terminal segment of antenna more than 1.6 times as long as preceding two segments together ..... *P. parvicorpus* sp. nov. [p.86]

- Eye consisting of at least 10 ommatidia; terminal segment of antenna at most 1.3 times as long as preceding two segments together 14

14 (13). Frons irregularly reticulate; hypostoma bearing a stout median process (Fig. 7C); frontal carina horizontal, extensively overhanging antennal scrobe (Fig. 7A); each dorsolateral portion of promesonotal dome produced outward (Fig. 7D) ..... *P. aristotelis* Forel [p.34]

- Frons longitudinally rugose; hypostoma bearing 0-3 median processes; the condition of frontal carina and antennal scrobe variable; each dorsolateral portion of promesonotal dome sometimes produced outward 15

15 (14). Masticatory margin of mandible having two denticles before basal angle; ventral faces of midcoxa and hindcoxa distinctly reticulate (this condition exclusively shared with *P. aristotelis* among others) 16

- Masticatory margin of mandible having at most one denticle before basal angle; ventral faces of midcoxa and hindcoxa completely smooth and shining 20

16 (15). Lateral portion of clypeus developed into a horn (Fig. 11) ..... *P. clypeocornis* sp. nov. [p.44]

- Lateral portion of clypeus never developed into a horn (Figs. 20B, 23B, 43B, 51B) 17

17 (16). Outer face of mandible sculptured with rugulae running from its base toward its masticatory margin (Fig. 43A) ..... *P. rugifera* sp. nov. [p.106]

- Outer face of mandible smooth and shining, or rugose laterally only around its base 18

18 (17). Frons (the area between frontal carinae) reticulate in its posterior part where spaces enclosed by rugulae punctured and dull ..... *P. tenebricosa* sp. nov. [p.121]

- Frons longitudinally rugose or rugoso-reticulate in its posterior part where spaces enclosed by rugulae almost smooth and shining 19

19 (18). Frons in profile relatively flat (Fig. 20B) ..... *P. hortensis* Forel [p.61]

- Frons in profile relatively convex (Fig. 23B) ..... *P. kikutai* sp. nov. [p.67]

20 (15). Frontal carina horizontal, extensively overhanging antennal scrobe (Fig. 52A); hypostoma always bearing one large median process (Fig. 52C) 21

- Frontal carina sometimes well developed, but not overhanging antennal scrobe extensively; hypostoma bearing 0-3 median processes 23

21 (20). Clypeus having a distinct median longitudinal carina (Fig. 42A) ..... *P. retivertex* sp. nov. [p.104]

- Clypeus lacking a median longitudinal carina 22

22 (21). Frontal lobe well developed and suberect (Fig. 52B); frons sparsely covered with longitudinal rugulae ..... *P. tjibodana* Forel [p.123]

- Frontal lobe poorly developed (Fig. 47B); frons densely covered with longitudinal rugulae ..... *P. sayapensis* sp. nov. [p.114]

23 (20). Each dorsolateral portion of promesonotum produced as a stout horn (Fig. 5D); eye small (distance between mandibular insertion and anterior margin of eye 2.1-2.6 times as long as maximal diameter of eye); postpetiole broad (2.3-2.8 times as broad as petiolar node)..... *P. angulicollis* sp. nov. [p.30]

- Each dorsolateral portion of promesonotum sometimes produced but not forming a stout horn; eye variable in size (distance between mandibular insertion and anterior margin of eye usually less than twice as long as maximal diameter of eye); postpetiole variable in width (usually less than 2.3 times as broad as petiolar node)..... 24

24 (23). Petiolar node in profile highly prominent (Figs. 14C, 45C, 46D); hypostoma always bearing a pair of median processes (Fig. 46C; occasionally the processes poorly developed in *P. elisae* Emery); mesopleuron divided by a transverse impression into two parts, of which lower part is always margined dorsally; alitrunk, or at least its large part, smooth and shining..... 25

- Petiolar node in profile usually poorly prominent (with exceptions as seen in *P. bugi* (Fig. 8E), in which, however, hypostoma bears three similar-sized median processes); when mesopleuron divided by a transverse impression into two parts, lower part is usually not margined dorsally (with exceptions as seen in *P. poringensis* sp. nov., in which alitrunk is reticulate)..... 27

25 (24). Dorsum of head completely covered with longitudinal rugulae (Fig. 46A)..... *P. sauberi* Forel [p.112]

- Dorsum of occipital lobe smooth and shining (Figs. 14A, 45A)..... 26

26 (25). Eight ommatidia present on longest axis of eye..... *P. elisae* Emery [p.49]

- Four to five ommatidia present on longest axis of eye..... *P. sarawakana* Forel [p.110]

27 (24). Alitrunk completely lacking standing hairs (Fig. 21D)..... *P. huberi* Forel [p.64]

- Alitrunk bearing standing hairs..... 28

28 (27). Propodeal spine extremely long, extending over petiolar node (Fig. 30C)..... *P. modiglianii* Emery [p.81]

- Propodeal spine at most slightly passing posterior end of propodeal lobe..... 29

29 (28). Dorsum of occipital lobe smooth and shining (or only weakly and sparsely rugose in *P. manukana* sp. nov. where postpetiole 2.4-2.6 times as broad as petiolar node)..... 30

- Dorsum of head including that of occipital lobe completely sculptured (or rugulae on occipital lobe weak in *P. orophila* sp. nov. where, however, postpetiole 1.6-1.7 times as broad as petiolar node)..... 36

30 (29). Hypostoma always lacking median processes; petiole less than 1.2 times as long as postpetiole.. 31

- Hypostoma bearing 1-3 median processes; (in part of *P. lucioccipitalis* sp. nov. hypostoma lacks all the median processes where petiole is more than 1.5 times as long as postpetiole)..... 33

31 (30). Distance between mandibular insertion and anterior margin of eye ca. 2.3-2.4 times as long as maximal diameter of eye (Fig. 19B)..... *P. havilandi* Forel [p.59]

- Distance between mandibular insertion and anterior margin of eye 1.4-1.6 times as long as maximal diameter of eye..... 32

32 (31). Postpetiole 2.4-2.6 times as broad as petiolar node; frontal carina conspicuous..... *P. manukana* sp. nov. [p.75]

- Postpetiole 1.8-1.9 times as broad as petiolar node; frontal carina inconspicuous..... *P. megacephala* (Fabricius) [p.77]

33 (30). Posterior declivity of promesonotal dome having a distinct prominence (Fig. 36D)..... *P. plinii* Forel [p.92]
- Posterior declivity of promesonotal dome lacking a distinct prominence..... 34
34 (33). Hypostoma bearing an indistinct median process, or lacking median process; clypeus having a median longitudinal carina (Fig. 26E)..... *P. lucioccipitalis* sp. nov. [p.73]
- Hypostoma bearing 2-3 median processes; clypeus lacking a conspicuous median longitudinal carina..... 35
35 (34). Promesonotum narrower dorsally than ventrally..... *P. deltea* sp. nov. [p.47]
- Promesonotum broader dorsally than ventrally..... *P. merimbun* sp. nov. [p.79]
36 (29). Posterior declivity of promesonotal dome lacking a distinct prominence; if the declivity has an inconspicuous prominence (as seen in *P. poringensis* sp. nov.), hypostoma bearing 2-3 distinct median processes..... 37
- Posterior declivity of promesonotal dome having a distinct prominence; if the declivity has just an inconspicuous prominence (as seen in *P. submonticola* sp. nov.), hypostoma completely lacking median processes..... 43
37 (36). Frontal lobe relatively large and erect (Fig. 50B)..... *P. tawauensis* sp. nov. [p.119]
- Frontal lobe relatively small (Figs. 8B, 9B, 35B)..... 38
38 (37). Posterior margin of head weakly concave in full-face view (Fig. 35A); dorsum of promesonotum smooth and shining (with several rugulae)..... *P. planidorsum* sp. nov. [p.91]
- Posterior margin of head strongly concave in full-face view; dorsum of promesonotum sculptured or smooth..... 39
39 (38). Hypostoma bearing three median processes (Figs. 8C, 9C)..... 40
- Hypostoma bearing a pair of stout median processes; if hypostoma bears three median processes, then the medianmost one is much reduced (as seen in *P. rabo* (Fig. 41C) and *P. poringensis* sp. nov.)..... 41
40 (39). Petiolar node relatively high (Fig. 8E)..... *P. bugi* Emery [p.37]
- Petiolar node relatively low (Fig. 9D)..... *P. butteli* Forel [p.39]
41 (39). Petiole almost twice as long as postpetiole (excluding helcium) (Fig. 18D); lateral face of promesonotum almost smooth and shining..... *P. gombakensis* sp. nov. [p.57]
- Petiole at most 1.7 times as long as postpetiole (excluding helcium) (Fig. 41D); lateral face of promesonotum sculptured..... 42
42 (41). Petiole ca. 1.7 times as long as postpetiole (excluding helcium) (Fig. 41D); outer face of mandible sparsely covered with very short appressed hairs..... *P. rabo* Forel [p.102]
- Petiole 1.3-1.4 times as long as postpetiole (excluding helcium) (Fig. 37C); outer face of mandible sparsely covered with relatively long decumbent hairs..... *P. poringensis* sp. nov. [p.94]
43 (36). Hypostoma bearing three low median processes, of which each lateral one is partly combined with the process just mesal to mandibular insertion (Fig. 6C)..... *P. annexus* sp. nov. [p.32]
- If hypostoma bears 2-3 median processes, then each lateral one is never combined with the process just mesal to mandibular insertion..... 44
44 (43). Hypostoma bearing a pair of stout median processes (Fig. 17C); petiole almost as long as postpetiole which is relatively massive (Fig. 17D)..... *P. ghigii* Emery [p.55]
- If hypostoma bears a pair of small or indistinct median processes, then petiole is at least 1.2 times

as long as postpetiole..... 45

45 (44). Propodeal spine elongate-triangular, with broad base (Fig. 10C, 49C); outer face of mandible bearing short or very short, appressed hairs..... 46

- Propodeal spine horn-like, with narrow base (Fig. 4D); outer face of mandible usually bearing relatively long, appressed or decumbent hairs..... 47

46 (45). Antennal scrobe margined below with a conspicuous carina anteriorly (Fig. 10A); mesopleuron without a distinct transverse impression..... *P. cariniceps* sp. nov. [p.41]

- Antennal scrobe present only around antennal insertion, and never margined below with a conspicuous carina (Fig. 49A); mesopleuron divided by a transverse impression into two parts, of which lower part margined dorsally..... *P. submonticola* sp. nov. [p.117]

47 (45). Posteriormost part of dorsum of occipital lobe almost transversely rugose (Fig. 34A)..... ..... *P. plagiaria* Fr. Smith [p.88]

- Dorsum of occipital lobe sculptured, but never transversely rugose..... 48

48 (46). Frontal carina weak; lateral face of occipital lobe smooth or very weakly rugoso-punctured.... ..... *P. orophila* sp. nov. [p.85]

- Frontal carina distinct; lateral face of occipital lobe distinctly rugoso-reticulate..... 49

49 (48). Posterior margin of head strongly concave in full-face view (Fig. 4A, B)..... *P. aglae* Forel [p.27]

- Posterior margin of head weakly concave in full-face view (Figs. 16A, 22A)..... 50

50 (49). Distance between mandibular insertion and anterior margin of eye 1.3-1.4 times as long as maximal diameter of eye (Fig. 16B)..... *P. fervens* Fr. Smith [p.63]

- Distance between mandibular insertion and anterior margin of eye 1.7-2.0 times as long as maximal diameter of eye (Fig. 22B)..... *P. inornata* sp. nov. [p.66]

B. Minors

1. Antenna with 3-segmented club..... 5

- Antenna with 5-segmented club, or without conspicuous club (Figs. 25F, 40G, 44G)..... 2

2 (1). Apical five antennal segments distinctly elongate, and forming conspicuous club (Figs. 40G, 44G); posterior part of head never forming elongate neck (Figs. 40F, 44F)..... 3

- Antenna lacking conspicuous club (Fig. 25F); posterior part of head forming extremely elongate neck (Fig. 25D, E)..... 4

3 (2). Promesonotal dome relatively high; metanotal groove in profile indistinct; in profile posterior declivity of promesonotal dome and dorsum of propodeum bearing ca. 10 standing hairs in total (Fig. 40H)..... *P. quinata* Eguchi [p.100]

- Promesonotal dome relatively low; metanotal groove in profile distinct; in profile posterior declivity of promesonotal dome and dorsum of propodeum bearing more than 20 standing hairs in total (Fig. 44H)..... *P. sabahna* Eguchi [p.108]

4 (2). Propodeal spine more than 4 times as long as diameter of propodeal spiracle (Fig. 31D); body light brown to brown..... *P. montana* Eguchi [p.83]

- Propodeal spine 2-2.5 times as long as diameter of propodeal spiracle (Fig. 25G); body brown to dark brown..... *P. comata* Fr. Smith [p.45], or *P. longipes* Fr. Smith [p.71]

5 (1). Promesonotum armed with a pair of long and pointed spines (Figs. 38G, 39E)..... 6

- Promesonotum unarmed, or armed with a pair of processes, but the processes never developed into long and pointed spines (the processes of *P. aristotelis* (Fig. 7G) well developed but truncate or blunt apically)..... 10

6 (5). Propodeal spine elongate-triangular, ca. 1.5 times as long as diameter of propodeal spiracle (Fig. 39E); head smooth and shining..... *P. quadricuspis* Emery [p.98]

- Propodeal spine horn-like, more than 4 times as long as diameter of propodeal spiracle (Fig. 38G); head usually sculptured at least partly (in *P. acantha* sp. nov. head sometimes almost smooth and shining)..... 7

7 (6). Petiolar node in profile acute at apex (Fig. 3G); dorsum of alitrunk in profile bearing less than 10 standing hairs (Fig. 3G)..... *P. acantha* sp. nov. [p.25]

- Petiolar node in profile blunt at apex (Fig. 24E); dorsum of alitrunk in profile usually bearing more than 20 standing hairs (Fig. 24E)..... 8

8 (7). Head punctured, or largely smooth and shining and partly punctured.... *P. spinicornis* sp. nov. [p.116]

- Head strongly reticulate..... 9

9 (8). Body smaller (AL 1.00-1.20 mm); propodeal spine usually directed upward (Fig. 38G)..... *P. quadrensis* Forel [p.96]

- Body larger (AL 1.74-1.83 mm); propodeal spine usually directed posterodorsally (Fig. 24E)..... *P. lokitae* Forel [p.69]

10 (5). Legs from apex of femur to apex of tersus ivory-white contrasted with the remainder of femur which is dark brown..... *P. fantasia* Chapman [p.51]

- Legs almost unicolored..... 11

11 (10). Eye consisting of 5-6 ommatidia..... *P. parvicorpus* sp. nov. [p.86]

- Eye consisting of more than 10 ommatidia..... 12

12 (11). Head at least above subocular level distinctly sculptured; occipital carina weak or absent dorsally on head; posterior declivity of promesonotal dome always without a distinct prominence..... 13

- Head not, or only weakly, sculptured; occipital carina variable in condition; posterior declivity of promesonotal dome with, or without, a prominence..... 23

13 (12). Dorsum of head punctured; ventrolateral face of head below subocular level smooth and shining in at least its anterior half..... 14

- Dorsum of head punctured or reticulate; ventrolateral face of head below subocular level entirely punctured or reticulate; when venter of head less-sculptured (in *P. retivertex* sp. nov. and *P. gombakensis* sp. nov.), dorsum of head not punctured but largely rugoso-reticulate..... 16

14 (13). In profile head below subocular level punctured and dull in its posterior half; petiolar node higher (Fig. 8G); eye broader..... *P. bugi* Emery [p.37]

- In profile head below subocular level entirely smooth and shining; petiolar node lower (Figs. 43E, 52F); eye narrower..... 15

15 (14). Body brown..... *P. rugifera* sp. nov. [p.106]

- Body dark brown to blackish brown..... *P. tenebricosa* sp. nov. [p.121]

16 (13). Both head and alitrunk reticulate; propodeal spine ca. 6 times as long as diameter of propodeal spiracle (Fig. 47E)..... *P. sayapensis* sp. nov. [p.114]

- At least mesopleuron and lateral face of propodeum punctured; propodeal spine usually less than

4.5 times as long as diameter of propodeal spiracle 17
17 (16). Promesonotum with a pair of well-developed spines with blunt apices (Fig. 7G) ..... *P. aristotelis* Forel [p.34]
- Promesonotum unarmed, or only with a pair of low tubercles which never develop into distinct spines (Figs. 5G, 37E) 18
18 (17). Median part of clypeus distinctly punctured and dull 19
- Median part of clypeus smooth and shining 20
19 (18). Posterior declivity of promesonotal dome relatively steep (Fig. 52F); propodeal spine longer than that of *P. rabo* (Fig. 41F) ..... *P. tjibodana* Forel [p.123]
- Posterior declivity of promesonotal dome relatively gentle (Fig. 41F); propodeal spine shorter than that of *P. tjibodana* (Fig. 52F) ..... *P. rabo* Forel [p.102]
20 (18). Promesonotum without a pair of tubercles (Figs. 18F, 42E); propodeal spine triangular or elongate-triangular, at most twice as long as diameter of propodeal spiracle 21
- Promesonotum with a pair of low tubercles (Figs. 5G, 37E); propodeal spine horn-like, at least 3 times as long as diameter of propodeal spiracle 22
21 (20). Promesonotum smooth and shining ..... *P. gombakensis* sp. nov. [p.57]
- Lateral part of promesonotum weakly punctured ..... *P. retivertex* sp. nov. [p.104]
22 (20). Ventrolateral face of head below subocular level punctured ..... *P. angulicollis* sp. nov. [p.30]
- Ventrolateral face of head below subocular level reticulate ..... *P. poringensis* sp. nov. [p.94]
23 (12). Propodeal spine extremely long, extending over petiole (Fig. 30E) .... *P. modiglianii* Emery [p.81]
- Propodeal spine sometimes long, but never extending over petiolar node 24
24 (23). Alitrunk completely lacking standing hairs (Fig. 21F) ..... *P. huberi* Forel [p.64]
- Alitrunk bearing standing hairs 25
25 (24). Declivitous face of promesonotal dome without any distinct prominence 26
- Declivitous face of promesonotal dome with a prominence 39
26 (25). Petiolar node very high (Figs. 14F, 45E, 46G); mesopleuron divided into two parts, of which lower part is more or less margined dorsally 27
- Petiolar node not so high; mesopleuron usually not divided into upper and lower parts; if it is divided into two parts, the lower part is usually not margined dorsally 28
27 (26). Longest axis of eye having 4 ommatidia; body yellowish brown ... *P. sarawakana* Forel [p.110]
- Longest axis of eye having at least 5 ommatidia; body yellowish brown to dark brown ..... *P. sauberi* Forel [p.112] or *P. elisae* Forel [p.49]
28 (26). Occipital carina complete 29
- Occipital carina almost evanescent, or absent dorsally on head 36
29 (28). Distance between mandibular insertion and anterior margin of eye 1.5-1.6 times as long as maximal diameter of eye ..... *P. havilandi* Forel [p.59]
- Distance between mandibular insertion and anterior margin of eye at most 1.1 times as long as maximal diameter of eye 30
30 (28). Metanotal groove in profile being a deep emargination (Fig. 50D) ..... *P. tawauensis* sp. nov. [p.119]
- Metanotal groove shallow or indistinct (Figs. 23E, 26E, 27E, 28E, 49E, 53E) 31
31 (30). Petiole more than 1.7 times as long as postpetiole (Fig. 26E); anterior declivity of promesonotal dome in profile relatively steep ..... *P. lucioccipitalis* sp. nov. [p.73]

- Petiole at most 1.5 times as long as postpetiole; anterior declivity of promesonotal dome in profile relatively gentle 32

32 (31). Several conspicuous rugulae running immediately above eye.... *P. submonticola* sp. nov. [p.117]

- No conspicuous rugulae running immediately above eye 33

33 (32). Upper part of mesopleuron, and lateral face of propodeum largely smooth and shining..... 34

- Mesopleuron and lateral face of propodeum punctured 35

34 (33). Eye small, with ca. 5 ommatidia on longest axis; head in full-face view oval (Fig. 53D)..... *P. upeneci* Forel [p.125]

- Eye large, with ca. 10 ommatidia on longest axis; head in full-face view subrectangular (Fig. 27D).. *P. manukana* sp. nov. [p.75]

35 (33). Body yellowish brown; promesonotum with a pair of very low tubercles dorsolaterally..... *P. kikutai* sp. nov. [p.62]

- Body brown; promesonotum without tubercles..... *P. megacephala* (Fabricius) [p.77]

36 (28). Propodeal spine 3.5-4 times as long as diameter of propodeal spiracle (Fig. 13E)..... *P. deltea* sp. nov. [p.47]

- Propodeal spine at most twice as long as diameter of propodeal spiracle 37

37 (36). In profile promesonotum convex, with steep posterior declivity (Fig. 20G)..... *P. hortensis* Forel [p.61] or *P. clypeocornis* sp. nov. [p.44]

- In profile promesonotum evenly convex (Fig. 9F), or flat and low (Figs. 29E, 35F)..... 38

38 (37). Promesonotal dome in profile lower, and flatter dorsally (Figs. 29E, 35F); CI 89-95..... *P. merimbun* sp. nov. [p.71] or *P. planidorsum* sp. nov. [p.91]

- Promesonotal dome in profile higher, and convexer dorsally (Fig. 9F); CI 84-89..... *P. butteli* Forel [p.39]

39 (25). Promesonotum with a pair of low tubercles (Figs. 17F, 36F)..... 40

- Promesonotum without a pair of tubercles..... 41

40 (39). Distance between mandibular insertion and anterior margin of eye 1.3-1.5 times as long as maximal diameter of eye; postpetiole 2.3-2.5 times as broad as petiolar node; anterior declivity of promesonotal dome relatively steep (Fig. 36F); lateral face of promesonotum weakly punctured..... *P. ghigii* Emery [p.55]

- Distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye; postpetiole 2.0-2.2 times as broad as petiolar node; anterior declivity of promesonotal dome relatively gentle (Fig. 17F); lateral face of promesonotum smooth and shining..... *P. plinii* Forel [p.92]

41 (39). Prominence on posterior declivity of promesonotal dome, and dorsum of propodeum each bearing a pair of standing hairs (Fig. 10F)..... *P. cariniceps* sp. nov. [p.41]

- Prominence on posterior declivity of promesonotal dome, and dorsum of propodeum each bearing more than one pair of standing hairs (Fig. 4G)..... 42

42 (41). Occipital carina forming a well-developed flange, which is in full-face view narrowed at its base (Fig. 4E, F)..... *P. aglae* Forel [p.27]

- Occipital carina sometimes forming a flange, but in full-face view not narrowed at base..... 43

43 (42). Clypeus weakly and irregularly rugose and weakly shining..... *P. plagiaria* Fr. Smith [p.88]

- Clypeus smooth and shining..... 44

44 (43). Large part of dorsum of head very weakly punctured; promesonotal dome in profile higher

and rounder (Fig. 22E)..... *P. inornata* sp. nov. [p.66]
- Dorsum of head except the area around antennal insertion smooth over the surface; promesonotal dome in profile lower (Figs. 6F, 16E, 32E)..... 45
45 (44). Lower part of mesopleuron smooth and shining, or slightly punctured; petiole 0.9-1.0 times as long as postpetiole (Fig. 6F)..... *P. annexus* sp. nov. [p.32]
- Mesopleuron punctured; petiole at least 1.3 times as long as postpetiole (Figs. 16E, 32E)..... 46
46 (45). Head broader (CI 82-87)..... *P. fervens* Fr. Smith [p.53]
- Head narrower (CI 78-81)..... *P. orophila* sp. nov. [p.85]

C. Major and Minor workers

This key may better work when the sample at hand includes both the major and minor workers from the same colony.

1. Antenna with 3-segmented club..... 6
- Antenna with 5-segmented club (Figs. 40C, G, 44C, G), or without conspicuous club (Fig. 25F)..... 2
2 (1). Apical five antennal segments distinctly elongate and forming conspicuous club in both the subcastes (Figs. 40C, G, 44C, G); posterior part of head never forming elongate neck in the minor (Figs. 40F, 44F); hypostoma of the major bearing three low median processes; low subpetiolar process present in the major (Figs. 40E, 44E)..... 3
- Antenna lacking conspicuous club in both the subcastes (Fig. 25F); posterior part of head of the minor forming elongate neck (Fig. 25D, E); hypostoma of the major lacking distinct median processes; subpetiolar process absent in both the subcastes (Fig. 25C)..... 4
3 (2). Head of the major in profile distinctly impressed on vertex (Fig. 40B); promesonotal dome of the minor relatively high; metanotal groove of the minor in profile indistinct (Fig. 40H).....
..... *P. quinata* Eguchi [p.100]
- Head of the major in profile not, or slightly, impressed on vertex (Fig. 44B); promesonotal dome of the minor relatively low; metanotal groove of the minor in profile distinct (Fig. 44H).....
..... *P. sabahna* Eguchi [p.108]
4 (2). Propodeal spine more than 4 times as long as diameter of propodeal spiracle in the minor (Fig. 31D); body light brown to brown in both the subcastes..... *P. montana* Eguchi [p.83]
- Propodeal spine 2-2.5 times as long as diameter of propodeal spiracle in the minor (Fig. 25G); body reddish brown to dark brown in both the subcastes..... 5
5 (4). Head of the major densely bearing standing hairs over the surface (Fig. 12A, B); lateral face of occipital lobe distinctly rugose in the major; in profile dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing ca. 20 standing hairs in the major (Fig. 12C).....
..... *P. comata* Fr. Smith [p.45]
- Head of the major with sparse standing hairs only on frons and vertex (Fig. 25A, B); lateral face of occipital lobe weakly and finely rugose, or almost smooth and shining in the major; in profile dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing at most 10 standing hairs in the major (Fig. 25C)..... *P. longipes* Fr. Smith [p.71]
6 (1). Promesonotum armed with a pair of long and pointed spines in both the subcastes (Figs. 38D,

E, G, 39C, E); hypostoma of the major always bearing a pair of stout median processes (Fig. 38C). 7

- Promesonotum unarmed in both the subcastes, or armed with a pair of processes, but the processes never developing into long and pointed spines (the processes of the minor of *P. aristotelis* (Fig. 7G) well developed, but truncate or blunt apically in the minor); hypostoma of the major bearing 0-3 median processes..... 11

7 (6). Propodeal spine digitiform and blunt apically in the major (Fig. 39C), and elongate-triangular, ca. 1.5 times as long as diameter of propodeal spiracle in the minor (Fig. 39D); head of the minor smooth and shining..... *P. quadricuspis* Emery [p.98]

- Propodeal spine usually pointed apically in the major (Figs. 24C, 38E), and horn-like, more than 4 times as long as diameter of propodeal spiracle in the minor (Figs. 24E, 38G); head of the minor usually sculptured at least partly (in *P. acantha* sp. nov. head of the minor sometimes almost completely smooth and shining)..... 8

8 (7). Gaster of the major smooth and shining over the surface, or only anterior part of first gastral tergite around its articulation with postpetiole weakly punctured; petiolar node of both the subcastes in profile acute at apex (Fig. 3C, E); dorsum of alitrunk in profile bearing only less than 10 standing hairs in the minor (Fig. 3E)..... *P. acantha* sp. nov. [p.25]

- At least first gastral tergite of the major punctured and dull; petiolar node of both the subcastes in profile blunt at apex (Figs. 24C, 38E); dorsum of alitrunk in profile usually bearing more than 20 standing hairs in the minor (Figs. 24C, 38E)..... 9

9 (8). Head punctured, or largely smooth and shining but partly punctured in the minor..... *P. spinicornis* sp. nov. [p.116]

- Head strongly reticulate in the minor..... 10

10 (9). Propodeal spine elongate-triangular, with broad base in the major (Fig. 38E), and horn-like, usually directed upward in the minor (Fig. 38G); petiole of the major with low subpetiolar process (Fig. 38E); body smaller (*e.g.*, HW: 1.90-2.28 mm in the major, 0.67-0.78 mm in the minor)..... *P. quadrensis* Forel [p.96]

- Propodeal spine horn-like, with narrow base in the major (Fig. 24C), and horn-like, directed posterodorsally in the minor (Fig. 24E); petiole of the major without any subpetiolar process (Fig. 24C); body larger (*e.g.*, HW: 2.79-2.91 mm in the major, 1.04-1.11 mm in the minor)..... *P. lokitae* Forel [p.69]

11 (6). Legs from apex of femur to apex of tersus ivory-white contrasted with remainder of femur which is dark brown..... *P. fantasia* Chapman [p.51]

- Legs almost unicolored..... 12

12 (11). Frontal lobe extremely developed, extending beyond anterior margin of clypeus in the major (Fig. 53A, B)..... *P. upeneci* Forel [p.125]

- Frontal lobe sometimes developed, but never extending beyond anterior margin of clypeus in the major (Figs. 50, 52B)..... 13

13 (12). Eye consisting of 5-7 ommatidia in both the subcastes (Fig. 33B); terminal antennal segment more than 1.6 times as long as preceding two segments together in both the subcastes..... *P. parvicorpus* sp. nov. [p.86]

- Eye consisting of at least ten, usually more than 15, ommatidia in both the subcastes; terminal

antennal segment at most 1.3 times as long as preceding two segments together in both the subcastes..... 14

14 (13). Frons irregularly reticulate; hypostoma bearing a stout median process in the major (Fig. 7C; rarely the process is poorly developed); frontal carina horizontal, extensively overhanging antennal scrobe in the major (Fig. 7A, B); each dorsolateral portion of promesonotal dome angulate outward in the major (Fig. 7D), and armed with a pair of blunt spines in the minor (Fig. 7G)..... *P. aristotelis* Forel [p.34]

- Frons of the major longitudinally rugose; hypostoma bearing 0-3 median processes in the minor; condition of frontal carina and antennal scrobe variable in the major; each dorsolateral portion of promesonotal dome sometimes produced outward in the major, and sometimes armed with a pair of low tubercles in the minor (but the tubercles never developed into distinct spines as seen in *P. aristotelis*)..... 15

15 (14). Masticatory margin of mandible of the major having two denticles in front of basal angle; ventral faces of midcoxa and hindcoxa of the major distinctly reticulate (this condition exclusively shared with *P. aristotelis* among others)..... 16

- Masticatory margin of mandible of the major having at most a denticle in front of basal angle; ventral faces of midcoxa and hindcoxa of the major completely smooth and shining..... 20

16 (15). Head above subocular level and alitrunk punctured and dull in the minor..... 17

- Head and alitrunk smooth and shining in the minor..... 18

17 (16). Outer face of mandible of the major sculptured with rugulae running from its base toward its masticatory margin (Fig. 43A)..... *P. rugifera* sp. nov. [p.106]

- Outer face of mandible of the major rugose laterally only around at most its base..... *P. tenebricosa* sp. nov. [p.121]

18 (16). Occipital carina of the minor complete (Fig. 23D)..... *P. kikutai* sp. nov. [p.67]

- Occipital carina of the minor absent dorsally on head (Fig. 20F)..... 19

19 (18). Lateral portion of clypeus produced into a horn in the major (Fig. 11)..... *P. clypeocornis* sp. nov. [p.44]

- Lateral portion of clypeus never produced into a horn in the major (Fig. 20B)..... *P. hortensis* Forel [p.61]

20 (15). In the major frontal carina horizontal, overhanging antennal scrobe (Figs. 42A, 47A, 52A); hypostoma of the major always bearing a large median process (Fig. 52C); head of the minor always rugoso-reticulate or punctured..... 21

- In the major frontal carina sometimes well developed, but not overhanging antennal scrobe extensively; hypostoma of the major bearing 0-3 median processes; head of the minor smooth and shining, or sculptured..... 23

21 (20). Head weakly rugoso-reticulate and lateral face of alitrunk weakly punctured in the minor; clypeus of the major having a distinct median longitudinal carina (Fig. 42A)..... *P. retivertex* sp. nov. [p.104]

- Head and alitrunk distinctly punctured or reticulate in the minor; clypeus of the major lacking a median longitudinal carina (Figs. 47A, 52A)..... 22

22 (21). Head and alitrunk of the minor punctured; frontal lobe of the major well developed and suberect (Fig. 52B)..... *P. tjibodana* Forel [p.123]

- Head and alitrunk of the minor reticulate; frontal lobe of the major poorly developed (Fig. 47B)..... ..... *P. sayapensis* sp. nov. [p.114]

23 (20). Each dorsolateral portion of promesonotum produced as a blunt horn directed dorsolaterally in the major (Fig. 5D, E); eye of the major small (distance between mandibular insertion and anterior margin of eye 2.1-2.6 times as long as maximal diameter of eye; Fig. 5B); postpetiole broad in the major (2.3-2.8 times as broad as petiolar node)..... *P. angulicollis* sp. nov. [p.30]

- Each dorsolateral portion of promesonotum sometimes produced laterally but not forming a blunt horn directed dorsolaterally in the major (Fig. 8D); eye of the major variable in size (distance between mandibular insertion and anterior margin of eye usually less than twice as long as maximal diameter of eye); postpetiole variable in width in the major (usually less than 2.3 times as broad as petiolar node)..... 24

24 (23). Petiolar node in profile highly elevated in both the subcastes (Figs. 14C, F, 45C, E, 46D, G); hypostoma of the major always bearing a pair of median processes (Fig. 46C; occasionally the processes poorly developed in *P. elisae* Emery); mesopleuron of both the subcastes divided into two parts, of which lower part is usually margined dorsally; head and promesonotum always smooth and shining in the minor..... 25

- Petiolar node in profile usually relatively low in both the subcastes (with exceptions as seen in the minor of *P. gombakensis* sp. nov. (Fig. 18F)); hypostoma bearing 0-3 median processes (the major of *P. gombakensis* having a pair of median processes on hypostoma where the processes, however, extremely developed (Fig. 18C)); if mesopleuron is divided into two parts, the lower part is usually not margined dorsally; head and promesonotum smooth and shining, or sculptured in the minor..... 27

25 (24). Dorsum of head entirely longitudinally rugose up to posterior extremity of occipital lobe in the major (Fig. 46A)..... *P. sauberi* Forel [p.112]

- Dorsum of occipital lobe smooth and shining in the major (Figs. 14A, 45A)..... 26

26 (25). Longest axis of eye having 8 ommatidia in the major, and 6-7 ommatidia in the minor..... ..... *P. elisae* Emery [p.49]

- Longest axis of eye having 4-5 ommatidia in the major, and 4 ommatidia in the minor..... ..... *P. sarawakana* Forel [p.110]

27 (24). Alitrunk of both the subcastes completely lacking standing hairs (Fig. 21D, F)..... ..... *P. huberi* Forel [p.64]

- Alitrunk of both the subcastes bearing standing hairs..... 28

28 (27). Propodeal spine extremely long, extending over petiolar node in both the subcastes (Fig. 30C, E)..... *P. modiglianii* Emery [p.81]

- Propodeal spine extending at most slightly beyond posterior end of propodeal lobe in both the subcastes..... 29

29 (28). Dorsum of occipital lobe of the major smooth and shining (or only weakly and very sparsely rugose in *P. manukana* sp. nov. where postpetiole of the major 2.4-2.6 times as broad as petiolar node)..... 30

- Dorsum of head of the major sculptured (or rugulae on occipital lobe weak in *P. orophila* sp. nov. where, however, postpetiole of the major 1.6-1.7 times as broad as petiolar node)..... 36

30 (29). Hypostoma of the major always lacking median processes; petiole of both the subcastes less

than 1.2 times as long as postpetiole 31

- Hypostoma of the major bearing 1-3 median processes (in some specimens of *P. lucioccipitalis* sp. nov. median processes sometimes almost absent where petiole is more than 1.5 times as long as postpetiole in both the subcastes) 33

31 (30). Distance between mandibular insertion and anterior margin of eye 2.3-2.4 times as long as maximal diameter of eye in the major (Fig. 19B), and ca. 1.5 times in the minor ..... *P. havilandi* Forel [p.59]

- Distance between mandibular insertion and anterior margin of eye 1.4-1.5 times as long as maximal diameter of eye in the major, and 1.0-1.1 times in the minor 32

32 (31). Postpetiole 2.4-2.6 times as broad as petiolar node in the major; frontal carina of the major conspicuous ..... *P. manukana* sp. nov. [p.75]

- Postpetiole 1.8-1.9 times as broad as petiolar node in the major; frontal carina of the major inconspicuous ..... *P. megacephala* (Fabricius) [p.77]

33 (30). Posterior declivity of promesonotal dome having a distinct prominence in both the subcastes (Fig. 36D, F); promesonotal dome of the minor having a pair of low tubercles (Fig. 36F) ..... *P. plinii* Forel [p.92]

- Posterior declivity of promesonotal dome lacking a distinct prominence in both the subcastes; promesonotal dome of the minor unarmed 34

34 (33). Hypostoma of the major bearing an indistinct median process, or lacking median processes; clypeus of the major having a median longitudinal carina (Fig. 26A)... *P. lucioccipitalis* sp. nov. [p.73]

- Hypostoma of the major bearing 2-3 median processes; clypeus of the major lacking a median longitudinal carina 35

35 (34). Promesonotum of the major narrower dorsally than ventrally; propodeal spine of the minor 3.5-4 times as long as diameter of propodeal spiracle (Fig. 13E) ..... *P. deltea* sp. nov. [p.47]

- Promesonotum of the major broader dorsally than ventrally; propodeal spine of the minor twice as long as diameter of propodeal spiracle (Fig. 29E) ..... *P. merimbun* sp. nov. [p.79]

36 (29). Posterior declivity of promesonotal dome of the major lacking a distinct prominence; if the declivity has an inconspicuous prominence (*e.g.*, *P. poringensis* sp. nov.), hypostoma of the major bears 2-3 distinct median processes 37

- Posterior declivity of promesonotal dome of the major having a distinct prominence; if the declivity has just a small prominence as seen in *P. submonticola* sp. nov. (Fig. 49C), hypostoma of the major completely lacks median processes 43

37 (36). Promesonotum of the minor smooth and shining 38

- Promesonotum of the minor sculptured 41

38 (37). Promesonotal dome of the minor in profile very low and almost flat dorsally (Fig. 35F); in full-face view posterior margin of head of the major weakly concave (Fig. 35A) ..... *P. planidorsum* sp. nov. [p.91]

- Promesonotal dome of the minor in profile relatively convex dorsally; in full-face view posterior margin of head of the major usually distinctly concave 39

39 (38). Hypostoma of the major with a pair of very large median processes (Fig. 18C); dorsum of head of the minor rugoso-reticulate ..... *P. gombakensis* sp. nov. [p.57]

- Hypostoma of the major with 2-3 median processes; if two processes are present, they are much

smaller than those of *P. gombakensis* sp. nov. (Fig. 18C); head of the minor largely smooth and shining..... 40

40 (39). Frontal lobe of the major relatively large and erect (Fig. 50B)... *P. tawauensis* sp. nov. [p.119]

- Frontal lobe of the major relatively small (Fig. 9B)..... *P. butteli* Forel [p.39]

41 (37). Outer face of mandible of the major bearing long decumbent hairs (Fig. 37B); head of the minor reticulate..... *P. poringensis* sp. nov. [p.94]

- Outer face of mandible of the major sparsely bearing short appressed hairs; head of the minor punctured..... 42

42 (41). Distance between mandibular insertion and anterior margin of eye twice as long as maximal diameter of eye in the major (Fig. 41B); hypostoma of the major bearing three median processes, of which medianmost one is poorly developed (Fig. 41C)..... *P. rabo* Forel [p.102]

- Distance between mandibular insertion and anterior margin of eye ca. 1.4 times as long as maximal diameter of eye in the major (Fig. 8B); hypostoma of the major bearing three similar-sized median processes (Fig. 8C)..... *P. bugi* Wheeler [p.37]

43 (36). Hypostoma of the major bearing three low median processes, of which each lateral one is partly connected to the process just mesal to mandibular insertion (Fig. 6C)..... *P. annexus* sp. nov. [p.32]

- If hypostoma of the major bears 2-3 median processes, each lateral one is never connected to the process just mesal to mandibular insertion..... 44

44 (43). Hypostoma of the major bearing a pair of stout median processes (Fig. 17C); petiole of the major almost as long as postpetiole (Fig. 17D); promesonotum with a pair of low tubercles in the minor..... *P. ghigii* Emery [p.55]

- If hypostoma of the major bears a pair of small or indistinct median processes, petiole of the major is at least 1.2 times as long as postpetiole; promesonotum without a pair of low tubercles in the minor..... 45

45 (44). Propodeal spine of the major elongate-triangular, with broad base (Fig. 10C)..... 46

- Propodeal spine of the major horn-like, with narrow base (Fig. 4D)..... 47

46 (45). Antennal scrobe margined below with a conspicuous carina in the major anteriorly (Fig. 10A); mesopleuron of the major without a distinct transverse impression; posterior declivity of promesonotal dome of the minor with a low prominence (Fig. 10F)..... *P. cariniceps* sp. nov. [p.41]

- Antennal scrobe present only around antennal insertion, and never margined below with a conspicuous carina in the major (Fig. 49A); mesopleuron of the major divided by a transverse impression into two parts, of which the lower part is margined dorsally; posterior declivity of promesonotal dome of the minor without any prominence (Fig. 49E)..... *P. submonticola* sp. nov. [p.117]

47 (45). Posteriormost part of dorsum of occipital lobe of the major almost transversely rugose in the major (Fig. 34A)..... *P. plagiaria* Fr. Smith [p.88]

- Posteriormost part of dorsum of occipital lobe reticulate, rugoso-reticulate or longitudinally rugose, but never transversely rugose in the major..... 48

48 (47). Frontal carina of the major slight; lateral face of occipital lobe of the major smooth or very weakly rugoso-punctured..... *P. orophila* sp. nov. [p.85]

- Frontal carina of the major distinct; lateral face of occipital lobe of the major rugoso-reticulate..... 49

49 (48). Posterior margin of head of the major strongly concave (Fig. 4A, B); occipital carina of the minor

forming a flange, which is narrowed at its base in full-face view (Fig. 4D)..... *P. aglae* Forel [p.27]

- Posterior margin of head of the major weakly concave (Figs. 16A, 22A); occipital carina of the minor well developed, but never narrowed at its base in full-face view (Figs. 4D, 22D)..... 50

50 (49). Distance between mandibular insertion and anterior margin of eye 1.3-1.4 times as long as maximal diameter of eye in the major (Fig. 4B)..... *P. fervens* Fr. Smith [p.53]

- Distance between mandibular insertion and anterior margin of eye 1.7-2.0 times as long as maximal diameter of eye in the major (Fig. 22B)..... *P. inornata* sp. nov. [p.66]

Enumeration of Species

A total of 52 species are treated, and arranged in alphabetical order. Twenty three of them are described as new, of which descriptions are based on specimens from Borneo unless otherwise stated. For previously known species identifications are based on the examination of the type materials in most cases, and redescriptions are given for Bornean populations. Furthermore, specimens from adjacent areas are also examined, and listed in "Specimens examined" / "Other specimens examined". Distributional and biological notes are given as far as possible.

Pheidole Westwood

Pheidole Westwood, 1839: 219. Type species: *Atta providens* Sykes.
Oecophthora Heer, 1852: 15. Synonymised with *Pheidole* by Fr. Smith, 1858a: 282.
Leptomyrma Motschoulsky, 1863: 17. Synonymised with *Pheidole* by Emery, 1892: 166.
Allopheidole Forel, 1912b: 237, *Cardiopheidole* Wheeler, 1914: 48. Synonymised with *Pheidole* by Emery, 1921: 84.
Phidole Bingham, 1903: 220, unjustified emendation of *Pheidole*. Synonymised with *Pheidole* by Wheeler, 1922a: 806.
Macropheidole Emery, 1915b: 190. Synonymised with *Pheidole* by M. R. Smith, 1951: 800.
Epipheidole Wheeler, 1903: 664. Synonymised with *Pheidole* by Cole, 1965: 174.
Ceratopheidole Pergande, 1896: 889, *Conothoracoides* Strand, 1935: 176 (replacement name for *Conothorax* Karavaiev, 1935: 75), *Decapheidole* Forel, 1912b: 237, *Elasmopheidole* Forel, 1913: 43, *Electropheidole* Mann, 1921: 438, *Eriopheidole* Kusnezov, 1952: 10, *Gallardomyrma* Bruch, 1932: 271, *Hendecapheidole* Wheeler, 1922b: 3 (and its junior synonym: *Cephalomorium* Forel, 1922: 91), *Ischnomyrmex* Mayr, 1862: 738 (and its junior synonym: *Isopheidole* Forel,1912), *Pheidolacanthinus* Fr. Smith, 1865: 75, *Scrobopheidole* Emery, 1915b: 190, *Stegopheidole* Emery, 1915b: 190, *Sympheidole* Wheeler, 1904: 7, *Trachypheidole* Emery, 1915b: 190. These genus-level names were provisionally treated as junior synonyms of *Pheidole* by Brown (1973: 179-185), and his treatment was later confirmed by D. R. Smith (1979: 1365).
Parapheidole Emery, 1915a: 68. Synonymised with *Pheidole* by D. R. Smith, 1979: 1365.
Anergatides Wasmann, 1915: 281, *Bruchomyrma* Santschi, 1922: 248. Synonymised with *Pheidole* by Wilson, 1984: 327, 328.
Xenoaphaenogaster Baroni Urbani, 1964: 50. Synonymised with *Pheidole* by Bolton, 1987: 291.
Phidola Schulz, 1906: 1906: 155, unjustified emendation of *Pheidole*. Synonymised with *Pheidole* by Bolton, 1994: 106.

1. ***Pheidole acantha*** sp. nov. (Fig. 3)

Holotype Major, colony: Eg97-BOR-404, Mt. Kinabalu (near the Headquarter, ca. 1500 m alt.), Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1997, deposited in UMS.

Paratypes 4 majors, 10 minors and 1 queen from the same colony to which the holotype belongs, deposited

in BMNH, MCZ, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Mt. Kinabalu, ca. 1500 m alt., 10 majors, 19 minors and 2 queens (Eg97-BOR-377, 386) / 7 majors, 21 minors and 4 queens (7IV0714-1-B1; 15Q12S3, 15Q22B5; 118AC, 177A, 179A, 185A), TK / ca. 1800 m alt., 4 majors, 28 minors, 3 queens and 3 males (593A, 604A, 605A, 607A, 617A, 626A, 664A, 668A, 873A), TK; Poring, 1530 m alt. (East Ridge), 1 minor (code EB-2), CB, 1995 / 1930 m alt. (East Ridge), 1 minor (code GW-2), CB, 1995.

Major Measurements and indices (n=5): TL 4.3-5.3 mm, HL 1.98-2.37 mm, HW 2.13-2.50 mm, SL 1.17-1.27 mm, FL 1.63-1.88 mm, CI 101-107, SI 48-58, FI 71-87. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head weakly concave in full-face view (Fig. 3A); head in profile not impressed on vertex (Fig. 3B). Hypostoma with a pair of stout median processes. Clypeus with a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.7-1.9 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to about midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape reaching about 3/5 distance of head; terminal segment almost as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a pair of dorsolateral spines, which are slender, sharp, with narrow base; posterior declivity of the dome with a distinct prominence (Fig. 3C); the prominence in anterior view not or very weakly concave medially. Mesopleuron with an inconspicuous transverse impression. Propodeal spine horn-like, with narrow base, ca. 5 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.4 times as long as postpetiole (excluding helcium); petiolar node in profile acute (Fig. 3C), and in posterior view emarginate at apex; subpetiolar process absent. Postpetiole 1.9-2.2 times as broad as petiolar node, in profile usually angulate anteroventrally.

Frons and gena longitudinally rugose; vertex, and dorsal and lateral faces of occipital lobe reticulate; alitrunk irregularly rugoso-reticulate; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole largely smooth and shining; gaster largely smooth and shining, or weakly punctured on anterior half of first gastral tergite. Outer face of mandible sparsely covered with appressed to decumbent hairs which are 0.07-0.12 mm in length and (a little) longer than distance between piligerous punctures. Body brown to dark reddish-brown, with darker head (and abdomen); antennae and legs brown, lighter than alitrunk.

Minor Measurements and indices (n=5): TL 2.8-3.3 mm, HL 0.88-1.00 mm, HW 0.76-0.91 mm, SL 1.17-1.26 mm, AL 1.23-1.43 mm, FL 1.28-1.47 mm, CI 86-93, SI 139-153, FI 160-168. Head in full-face view oval (Fig. 3D), with distinct occipital carina. Clypeus with a median longitudinal carina, with anterior margin in full-face view weakly convex medially. Eyes situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 1.2-1.3 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.9-1.0 times as long as preceding two segments together. Promesonotal dome with a pair of dorsolateral spines, with a weak prominence on its posterior declivity (Fig. 3E). Mesopleuron without a transverse impression. Propodeal spine horn-like, with narrow base, 4-5 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.2 times

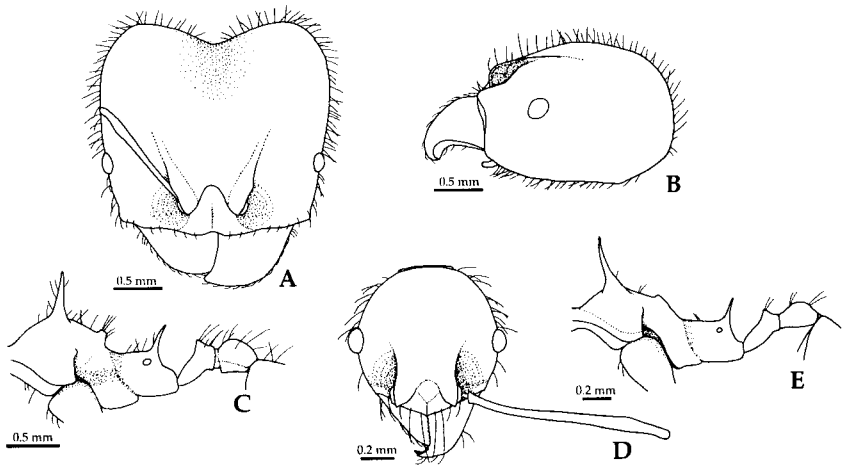

Fig. 3. *Pheidole acantha* sp. nov. (type material: Eg97-BOR-404): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist (petiole and postpetiole) in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

as long as postpetiole (excluding helcium); petiolar node in profile acute (Fig. 3E), and in posterior view emarginate at apex. Postpetiole 2.0-2.3 times as broad as petiolar node.

Clypeus smooth and shining with a few rugulae; remainder of head rugoso-reticulate; area between promesonotal spines smooth and shining; remainder of alitrunk punctured, or weakly reticulate with punctured enclosures; lateral face of petiolar pedicel very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Dorsum of alitrunk in profile bearing less than 10 standing hairs. Body colour pattern similar to that of the major.

Variation Sculpture of head in both the subcastes is generally weaker in the specimens from an elevation of ca. 1800 m than in those from that of ca. 1500 m on Mt. Kinabalu.

Recognition *P. acantha* sp. nov. is closely related to *P. lokitae* Forel, *P. quadrensis* Forel, *P. sperata* Forel, *P. quadricuspis* Emery and *P. spinicornis* sp. nov., and several undescribed species (see under *P. lokitae*), but can be recognised among the Bornean relatives by the characters given in the key.

Distribution Borneo.

Biology This species inhabits well-developed forest on Mt. Kinabalu from 1500-1800 m alt., and nests in rotting wood.

2. *Pheidole aglae* Forel (Figs. 4, 55)

Pheidole aglae Forel, 1913: 32, major, minor and queen (MHNG). Type locality: Bogor, Java. Lectotype designation and redescription of type material: Eguchi, 2001.

Pheidole exasperata var. *polita* Viehmeyer, 1914: 606, major and minor (ZMHB). Type locality: Singapore. The homonymy of *P. e. polita* Viehmeyer with *P. fabricator polita* Emery, 1894 was already established (for the replacement name *concordia*, see Santschi, 1916).

Pheidole exasperata var. *fusiformis* Viehmeyer, 1914: 607, major, minor and male (ZMHB). Type locality: D. Neuguinea [Irian Jaya]. Revised status as subspecies of *P. exasperata*: Bolton, 1995b. Lectotype designation and solution of synonymy (as a junior synonym of *P. aglae*): Eguchi, 2001.

Pheidole exasperata var. *concordia* Santschi, 1916: 242. Replacement name for *P. exasperata* var. *polita*

Viehmeyer. Revised status as subspecies of *P. exasperata*: Bolton, 1995b. Lectotype designation and solution of synonymy (as a junior synonym of *P. aglae*): Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 6 majors and 10 minors (Eg96-BOR-165, 229); Mahua Waterfall area, 6 majors, 7 minors, 2 queens and 5 males (Eg00-BOR-121, 126); Poring, 450-500 m alt., 3 majors, 5 minors and 1 male (Eg96-BOR-266) / ca. 600 m alt., 4 majors, 9 minors and 1 queen (6X2606-4-E, 6X2906-5-Ba, 6XII0606S35, 6XII2306-26-Fb), TK / 800 m alt. (East Ridge), 1 minor (code BW-1), CB, 1995 / 1130 m alt. (East Ridge), 1 minor (code CW-2), CB, 1995; Sayap Kinabalu, 3 majors, 9 minors and 2 queens (Eg96-BOR-061, 068) / 9 majors, 27 minors and 4 queens (SB96-SKY-41, 42, 47) / 2 majors, 4 minors and 1 queen (Eg96-BOR-072), Y. Hashimoto leg., 1996; Sepilok forest, 12 majors, 34 minors, 1 queen and 16 males (Eg97-BOR-416, 422, 463, 465, 466; Eg98-BOR-863); Tawau Hills Park, 7 majors, 23 minors and 2 queens (Eg96-BOR-008, 022, 026, 033, 038). Sarawak, Malaysia: Bako N. P., 1 major and 1 minor (GC), SKY, 1993; Lambir Hills N. P., 2 majors, 11 minors and 5 males (Eg98-BOR-805, 807); Niah N. P., 2 minors (GC), SKY, 1993; Sg. Segrak, 1 minor (GC), K. Het leg., 1993; Ubah Ribu, Engkari, 1 major and 1 minor (GC), K. Het leg., 1994. Brunei: Merimbun Heritage Park, 1 major, 4 minors and 1 queen (Eg99-BOR-154). E. Kalimantan, Indonesia: Kutai N. P., 1 minor (GC), T. Yajima leg., 1986. MALAY PENINSULA. Malaysia: Ulu Gombak, 3 majors and 6 minors (FI96-620). SUMATRA, Indonesia. Ulu Gadut, nr. Padang, W. Sumatra, 2 minors, SNS. JAVA, Indonesia. Kebun Raya, Bogor, 1 major and 2 minors (D11), MK, 1997; Pangandaran, W. Java, 1 minor (FI95-640); Ujung Kulon, W. Java, 1 major, 2 minors and 1 queen (FI97-138). W. NEW GUINEA (Irian Jaya, Indonesia). Depapre, nr. Jayapura, 2 majors, 20 minors and 3 queens (Eg98-IRI-704, 706, 714).

Major Measurements and indices (n=10): TL 3.5-4.6 mm, HL 1.51-1.98 mm, HW 1.33-1.71 mm, SL 1.08-1.17 mm, FL 1.47-1.60 mm, CI 81-88, SI 68-81, FI 94-113. Head broadest at 1/2-5/8 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 4A), in profile weakly or hardly impressed on vertex (Fig. 4C). Hypostoma bearing three low median processes. Clypeus rarely with a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.8 times as long as maximal diameter of eye. Frontal carina distinct, extending backward to 7/10-3/4 distance of head (Fig. 4A). Antennal scrobe very weak, running along frontal carina. Antenna with 3-segmented club; scape extending backward to about 3/4 distance of head; terminal segment ca. 0.8 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 4D); the prominence in anterior view not concave medially. Mesopleuron with an inconspicuous transverse impression, or without impression. Propodeal spine horn-like, straight or slightly curved, with narrow base, 3.5-4 times as long as diameter of propodeal spiracle. Petiole in profile cuneiform, 1.2-1.4 times as long as postpetiole (excluding helcium); petiolar node in posterior view not or very weakly emarginate at apex. Postpetiole in dorsal view subpentagonal, 2.1-2.5 times as broad as petiolar node.

Frons to vertex longitudinally rugose; dorsal and lateral faces of occipital lobe reticulate; promesonotum in dorsal view transversely rugose, with smooth and shining interspaces; mesopleuron and lateral face of propodeum weakly rugoso-reticulate, with punctured enclosures; lateral face of petiole weakly punctured; dorsum of petiole smooth and shining; postpetiole and anterior part of first gastral tergite usually weakly or very weakly punctured. Outer face of mandible covered with relatively long decumbent hairs, which are 0.08-0.10 mm in length and almost as long as distance between piligerous punctures. Body brown, reddish-brown or dark reddish-brown, with a little darker abdomen; flagella and tarsi lighter than alitrunk.

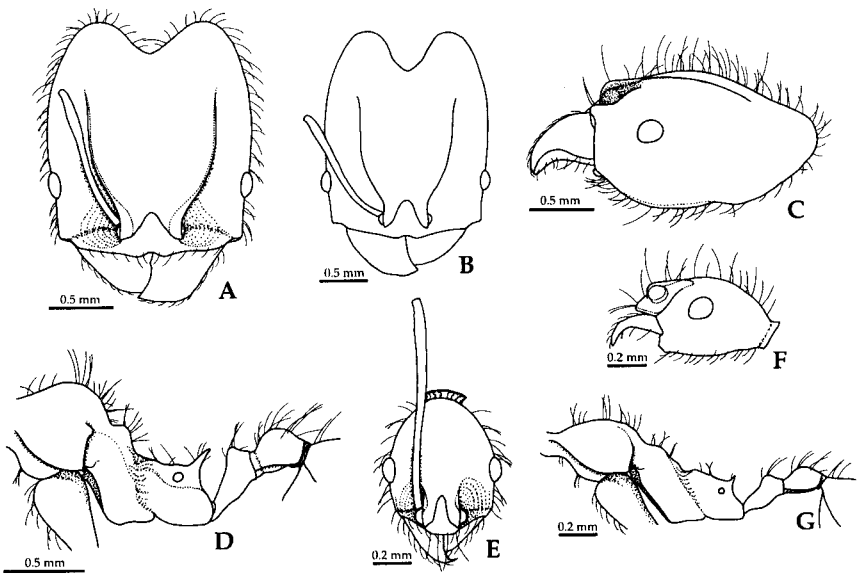

Fig. 4. *Pheidole aglae* Forel (A, C-G: Eg96-BOR-229; B: Eg96-BOR-072): A, B, major, head in full-face view; C, same, head in profile; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, head in profile; G, same, alitrunk and waist in profile.

Minor Measurements and indices (n=10): TL 2.7-3.0 mm, HL 0.77-0.91 mm, HW 0.55-0.65 mm, SL 1.07-1.30 mm, AL 1.14-1.33 mm, FL 1.18-1.45 mm, CI 69-73, SI 187-202, FI 209-225. Head in full-face view oval; occipital carina forming a well-developed flange (Fig. 4E, F). Clypeus without a median longitudinal carina (or rarely with inconspicuous carina), with anterior margin in full-face view truncate medially. Eyes situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.7-0.8 times as long as preceding two segments together. Promesonotal dome with a low prominence on its posterior declivity (Fig. 4G). Mesopleuron without a transverse impression. Propodeal spine elongate-triangular, 1.5-2.5 times as long as diameter of propodeal spiracle. Petiole in profile cuneiform, 1.2-1.3 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, ca. 2.0 times as broad as petiolar node.

Area between antennal insertion and eye weakly punctured; clypeus smooth and shining, or very weakly punctured; remainder of head smooth and shining (rarely punctured weakly); promesonotal dome smooth and shining, or concentrically puncto-rugose in dorsal view; remainder of alitrunk punctured; lateral face of petiole punctured; dorsum of petiole, and postpetiole and gaster almost smooth and shining. Prominence on posterior declivity of promesonotum, and dorsum of propodeum in profile each bearing at least two pairs of standing hairs. Body colour pattern similar to that of the major.

Variation Majors from Poring and Sayap Kinabalu have, in general, a deeper emargination on posterior margin of head (Fig. 4B) than those from other localities in Borneo, although intermediate conditions occur when we observe all the available Bornean specimens.

Recognition This relatively large-sized species, with 3-segmented antennal club, is recognisable among Indo-Malayan congeners by having minor's head with occipital carina forming a well-developed frange. The most similar species is the sympatric *P. cariniceps* sp. nov., but in the latter antennal scrobe of the major is margined below by a marked carina; propodeal spine of the major has broad base (Fig. 10C); prominence on posterior declivity of promesonotum, and dorsum of propodeum bears a pair of standing hairs in the minor (Fig. 10F). I could examine one syntype (minor) of *P. longicornis* Emery, 1888: 532. Morphological similarity between the minor of *P. aglae* and that of *P. longicornis* strongly suggests their conspecificity. However, I could not confirm it, since major(s) which should be included in the type material of *P. longicornis* according to Emery's original description could not be examined.

Distribution Southern Malay Peninsula, Singapore, Borneo, Sumatra, Java and New Guinea (Fig. 55).

Bionomics This species inhabits well-developed forests (including primary and well-recovered secondary forests) from lowlands to hill areas. It nests in rotting wood blocks and logs on the forest floor. I have never encountered colonies which include more than one dealate queen.

3. *Pheidole angulicollis* sp. nov. (Fig. 5)

Holotype Major, Eg00-BOR-100, Mahua Waterfall area (ca. 1000 m alt.), Crocker Range National Park, Sabah, E. Malaysia (Borneo), K. Eguchi leg., 2000, deposited in UMS.

Paratypes 5 majors (one of them is teneral), 22 minors and 1 queen from the same colony to which the holotype belongs, deposited in BMNH, MCZ, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sarawak, Malaysia: Lambir Hills N. P., 9 minors (GC), SKY, 1997 / 4 majors, 5 minors and 1 queen (bottle code: 97-01), SKY, 1997.

Major Measurements and indices (n=9): TL 2.6-3.6 mm, HL 1.26-1.93 mm, HW 1.11-1.66 mm, SL 0.58-0.76 mm, FL 0.72-1.05 mm, CI 84-88, SI 46-54, FI 63-66. Head broadest at around 1/2-3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 5A), in profile not impressed on vertex (Fig. 5B). Hypostoma bearing three distinct median processes, of which medianmost one is stout (Fig. 5C). Clypeus without a median longitudinal carina, with anterior margin weakly concave medially. Eye situated just in front of 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 2.1-2.6 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to 1/3-2/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to 1/2-3/5 distance of head; terminal segment 1.0-1.1 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotum forming a high dome, with a small or inconspicuous prominence on its posterior declivity (Fig. 5E); the prominence in anterior view not concave medially; each dorsolateral portion of the dome produced as a stout horn directing dorsolaterally on each side (Fig. 5D, E). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, 3.0-4.5 times as long as diameter of propodeal spiracle. Petiole 1.2-1.3 times as long as postpetiole (excluding helcium); petiolar node high, in posterior view not emarginate at apex. Postpetiole 2.3-2.8 times as broad as petiolar node.

Frons and gena longitudinally rugose; vertex, and dorsal and lateral faces of occipital lobe

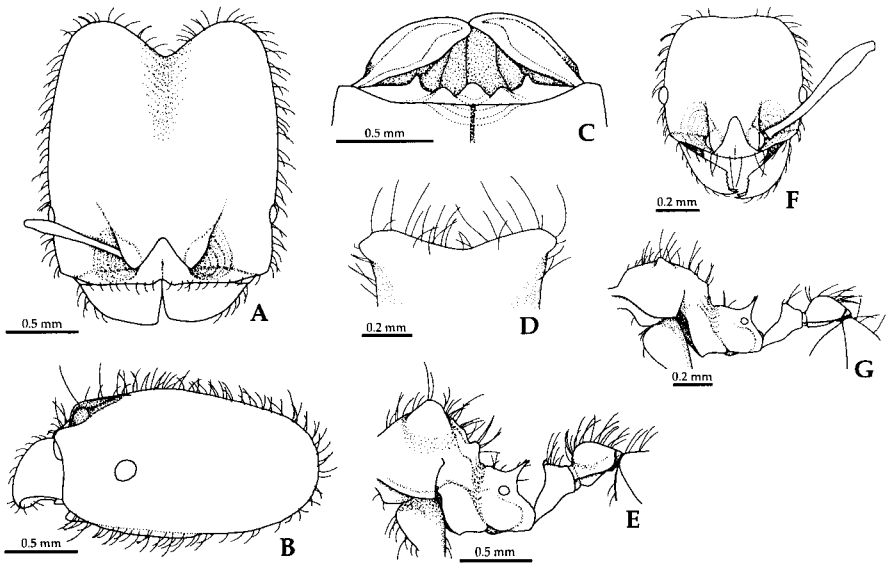

Fig. 5. *Pheidole angulicollis* sp. nov. (type material: Eg00-BOR-100): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, promesonotum in anterior view; E, same, alitrunk and waist in profile; F, minor, head in full-face view; G, same, alitrunk and waist in profile.

reticulate, with enclosures smooth and shining or weakly punctured; anterior face of promesonotum smooth and shining; remainder of promesonotal dome irregularly rugoso-reticulate; mesopleuron and lateral face of propodeum rugoso-reticulate weakly and shining, or punctured and dull; petiole weakly punctured laterally, and smooth and shining dorsally; postpetiole smooth and shining; or its dorsal face rugose transversely with punctured and dull interspaces, and lateral face punctured; at least anterior part of first gastral tergite weakly or conspicuously punctured and weakly shining. Outer face of mandible covered with decumbent hairs, which are 0.07-0.12 mm in length and longer than distance between piligerous punctures. Body reddish-brown with darker head, or dark reddish-brown with lateral faces of alitrunk, waist and abdomen brown; antennae and legs lighter than alitrunk.

Minor Measurements and indices (n=10): TL 1.3-2.4 mm, HL 0.50-0.68 mm, HW 0.47-0.62 mm, SL 0.48-0.65 mm, AL 0.67-0.90 mm, FL 0.49-0.73 mm, CI 91-96, SI 101-106, FI 104-117. Head in full-face view with slightly concave posterior margin (Fig. 5F); occipital carina evanescent dorsally on head. Clypeus with a weak median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and the anterior margin of eye ca. 1.1 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 1/5-1/4 length; terminal segment almost as long as preceding two segments together. Promesonotum forming a low and weakly convex dome, with a pair of low but distinct tubercles; posterior declivity of the dome at most with an inconspicuous prominence (Fig. 5G). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, 3-3.5 times as long as diameter of propodeal spiracle. Petiole 1.2-1.3 times as long as postpetiole

(excluding helcium); petiolar node high, in posterior view not emarginate at apex. Postpetiole 2.0-2.2 times as broad as petiolar node.

Clypeus smooth and shining, or very weakly punctured and weakly shining with several rugulae; remainder of dorsal face of head above subocular level weakly rugoso-reticulate, with enclosures smooth and shining or punctured and dull; ventral face of head below subocular level punctured and dull, or reticulate with enclosures very weakly punctured; dorsum of promesonotum reticulate, with enclosures smooth and shining or punctured and dull; remainder of alitrunk punctured and dull; lateral face of petiolar pedicel weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body yellowish-brown to brown with lighter waist and gaster; legs lighter than alitrunk.

Variation Both the subcastes collected from Mahua Waterfall area are much larger in size and darker in color than those from Lambir; horns on promesonotal dome of the major are well developed in the latter than in the former.

Recognition This species is very peculiar among Indo-Chinese and Indo-Malayan congeners in having the following characteristics in the major: each dorsolateral portion of promesonotal dome develops into a stout horn on each side (Fig. 5D); head without frontal carina and antennal scrobe (Fig. 5A); eye relatively small; postpetiole relatively large.

Distribution Borneo.

Bionomics This species inhabits well-developed forests in lowlands and hill areas. A colony collected from Mahua Waterfall area (Eg00-BOR-100) nested in the soil under a stone, and consisted of only one dealate queen, majors, minors and immatures.

4. *Pheidole annexus* sp. nov. (Fig. 6)

Holotype Major, colony: Eg96-BOR-478, Sepilok forest, Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1998, deposited in UMS.

Paratypes 5 majors and 6 minors from the same colony to which the holotype belongs, deposited in BMNH, MCZ, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 7 majors, 18 minors and 1 queen (Eg96-BOR-129, 170, 248) / 1 minor, CB, 1998-1999; Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Sepilok forest, 21 majors, 43 minors and 3 queens (Eg97-BOR-419, 423, 467, 472, 483; Eg98-BOR-874); Tawau Hills Park, 1 major, 4 minors and 1 queen (Eg96-BOR-023). Brunei: Merimbun Heritage Park, 1 major, 2 minors and 1 queen (Eg99-BOR-607). MALAY PENINSULA. Malaysia: Ulu Gombak, 1 major and 1 minor (FI99-135). SUMATRA, Indonesia. Sungai Dareh, W. Sumatra, 1 major and 2 minors (FI92-214).

Major Measurements and indices (n=5): TL 2.4-2.7 mm, HL 1.08-1.22 mm, HW 1.03-1.16 mm, SL 0.64-0.78 mm, FL 0.85-1.03 mm, CI 95-96, SI 60-67, FI 81-89. Head broadest at about 1/2-3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 6A), in profile not impressed on vertex (Fig. 6B). Hypostoma with three poorly developed median processes, of which each lateral one is partly combined with the process just mesal to mandibular base (Fig. 6C). Clypeus with a weak median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.7 times as long as maximal diameter of eye. Frontal carina extending backward to 3/4 distance of head. Antennal scrobe inconspicuous, running along frontal carina. Antenna with 3-segmented club; scape extending backward to about 3/4 distance of head; terminal segment ca. 0.9 times as long as preceding two

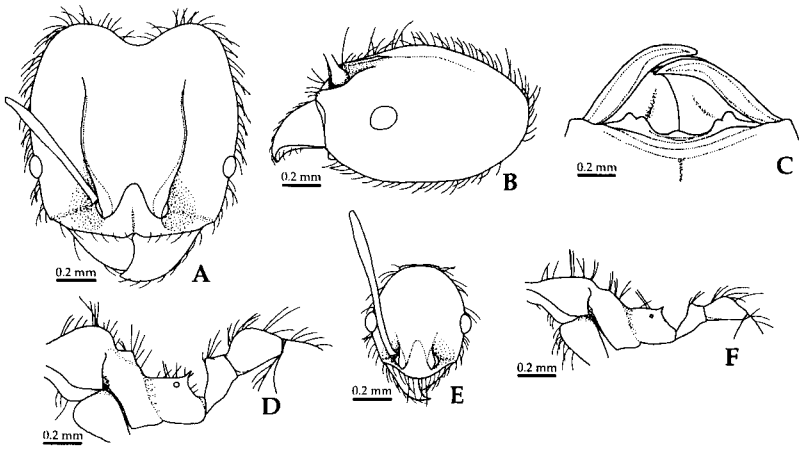

Fig. 6. *Pheidole annexus* sp. nov. (type material: Eg96-BOR-478): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.

segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 6D); the prominence in anterior view not or very weakly concave medially. Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, straight or slightly curved, 2.5-3 times as long as diameter of propodeal spiracle. Petiole cuneiform, 0.9-1.0 times as long as postpetiole (excluding helcium) (Fig. 6D); petiolar node low, in posterior view not or hardly emarginate at apex. Postpetiole in dorsal view subpentagonal, 2.3-2.4 times as broad as petiolar node.

Frons and area between mandibular insertion and eye longitudinally rugose; area between antennal scrobe and subocular level, vertex, and dorsal and lateral faces of occipital lobe rugoso-reticulate; dorsum of promesonotum with transverse rugulae but shining; lateral face of promesonotum weakly rugose or rugoso-reticulate; mesopleuron and lateral face of propodeum very weakly punctured, or partly smooth and shining; lateral faces of petiolar pedicel and postpetiole weakly or very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible covered with relatively long decumbent hairs, which are 0.06-0.13 mm in length and (a little) longer than distance between piligerous punctures. Body brown with a little darker gaster; legs sometimes a little lighter than alitrunk.

Minor Measurements and indices (n=5): TL 1.8-2.1 mm, HL 0.56-0.64 mm, HW 0.48-0.53 mm, SL 0.70-0.82 mm, AL 0.80-0.91 mm, FL 0.80-0.93 mm, CI 81-85, SI 147-162, FI 168-183. Head in full-face view oval (Fig. 6E), with distinct occipital carina. Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate, or slightly concave medially. Eyes situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 1.1-1.2 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by more than its 1/3 length; terminal segment ca. 0.8 times as long as preceding two segments together. Promesonotal dome with a low prominence on its posterior declivity (Fig. 6F). Mesopleuron without a distinct transverse impression. Propodeal spine small, elongate-triangular,

almost twice as long as diameter of propodeal spiracle. Petiole cuneiform, 0.9-1.0 times as long as postpetiole (excluding helcium) (Fig. 6F); petiolar node low, in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, 2.0-2.3 times as broad as petiolar node.

Head and promesonotum smooth and shining; mesopleuron and lateral face of propodeum almost smooth and shining, or very weakly punctured partly; lateral face of petiolar pedicel very weakly punctured: dorsum of petiole, and postpetiole and gaster smooth and shining. Body light yellowish-brown.

Recognition This medium-sized species with general habitus is distinguished from other Indo-Malayan congeners by a combination of the following characteristics: hypostoma of the major bearing three poorly developed median processes of which each lateral one is partly combined with the process just mesal to mandibular insertion (Fig. 6C); posterior declivity of promesonotal dome having a prominence in both the subcastes (Fig. 6D, F); petiole 0.9-1.0 times as long as postpetiole in both the subcastes (Fig. 6D, F); promesonotum of the minor unarmed without any kind of tubercle (Fig. 6F).

Distribution Southern Malay Peninsula, Borneo and Sumatra.

Bionomics This inhabits well-developed forests. I have never encountered colonies which include more than one dealate queen.

5. *Pheidole aristotelis* Forel (Figs. 7, 59)

Pheidole aristotelis Forel, 1911a: 43, major, minor and male (MHNG). Type locality: Sarawak, Borneo. Lectotype designation and redescription of type material: Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 41 majors, 78 minors, 4 queens and 19 males (Eg96-BOR-110, 141B, 141C, 142, 143, 144, 187, 191, 197, 198, 205, 221, 228, 234, 235) / 1 minor, CB, 1998-1999 / 1 minor (GC), SKY, 1995; Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Gunong Rara, 8 majors, 15 minors and 31 males (Eg96-BOR-312, 317; Eg97-BOR-536); Mahua Waterfall area, 1 major and 1 minor (MA00-HO-010), HO, 2000; Poring, 450-500 m alt., 2 majors and 5 minors (Eg96-BOR-273) / 500-550 m alt., 2 majors and 5 minors (Eg96-BOR-304) / 560 m alt. (East Ridge), 1 minor (code AW-1), CB, 1995 / ca. 600 m alt., 31 majors, 48 minors, 4 queens and 2 males (6X2606-3-I1, 6X2906-6-Bb, 6X2906-5-Ja, 6X2906-6-Cb, 6X3006-10-5, 6XI0106-14-2, 6XI0106-14-6, 6XI0106-14-Ee, 6XI0106-14-Gb, 6XI0106-14-Ha, 6XI0106-16-Cc, 6XII0606-S3-6, 6XII0606-S3-8, 6XII2106-23-Aa, 6XII2306-Ba, 7III2606-29-5, 7III2606-29-7, 7III2606-29-Ad, 7III2606-29-Fa, 7III2606-29-Fc, 7VI0310-6-2b; 06Q33B4, 06Q50B5), TK / 1 minor (bait No. 85A), E. Aug leg., 1994 / 600-700 m alt., 2 minors (GC), SKY, 1995 / 700-800 m alt., 1 major and 6 minors (GC), SKY, 1995 / 800 m alt. (East Ridge), 1 minor (code BW-1), CB, 1995 / ca. 900 m alt., 10 majors, 15 minors and 1 queen (6XI2810-2-Ae, 7IV0310-5-Ae, 7IV0310-5-Ja, 7IV0310-6-2b; 09Q13B4, 09Q15B4, 09Q23B4, 09Q23S4), TK; Sayap Kinabalu, 3 majors, 10 minors and 2 males (SB96-SKY-48); Sepilok forest, 18 majors, 33 minors and 2 males (Eg97-BOR-445, 455, 456, 480, 499, 511; Eg98-BOR-882); Tawau Hills Park, 2 majors, 4 minors and 1 male (Eg96-BOR-010). Sarawak, Malaysia: Bako N. P., 2 minors (GC), SKY, 1993; Bt. Entimau (610 m alt.), 3 minors (GC), Mahmud leg., 1994; Lambir Hills N. P., 5 majors, 7 minors and 1 queen (Eg98-BOR-821). Brunei: Belalong Forest Section, 7 majors, 7 minors, 1 queen and 1 male (Eg99-BOR-205, 209); Merimbun Heritage Park, 16 majors, 18 minors, 2 queens and 4 males (Eg99-BOR-115, 117, 138, 141, 151, 508). E. Kalimantan, Indonesia: Bt. Soehart (UNMUL forest), 2 minors (GC), SKY, 1992; Kutai N. P., 1 major and 12 minors (GC), T. Yajima leg., 1993. MALAY PENINSULA. Thailand: Khao Chong, Trang Prov., 1 major and 4 minors (TH98-SKY-38). Malaysia: Ulu Gombak, 6 majors, 14 minors and 1 male (FI92MG-466; FI96-629, 683, 726; FI99-83). SINGAPORE. 1 minor (GC), SKY, 1993. SUMATRA, Indonesia. Ulu Gadut, nr. Padang, W. Sumatra, 9 majors, 14 minors, 1 queen and 1 male (FI96-190, 199; FI97-400, 401, 427, 440, 501); Bt. Sabala, W. Sumatra, 2 majors, 2 minors and 2 males (FI92-242); Sitiung, W. Sumatra, 1 major and 2 minors (FI93-264). JAVA, Indonesia. Mt. Halimun, 9 majors and 16 minors (FI96-372; FI98-343, 358, 372) / 3 majors and 6 minors (48, 10/17Ta), MK, 1998 and 1999. LOMBOK, Indonesia. Santong, N. Lombok, 3 majors and 9 minors (Colony code: KT-101), IKT. Ginarsa leg., 1998.

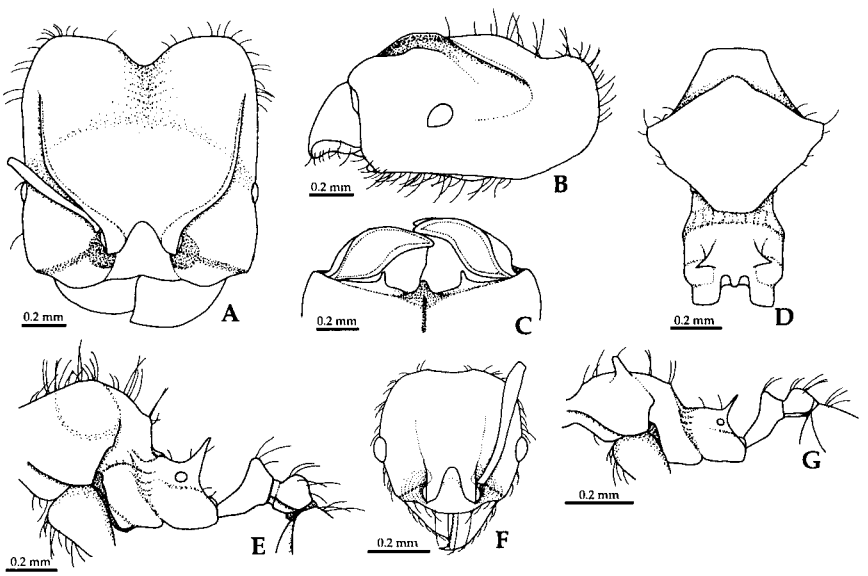

Fig. 7. *Pheidole aristotelis* Forel (Eg98-BOR-882): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk in dorsal view; E, same, alitrunk and waist in profile; F, minor, head in full-face view; G, same, alitrunk and waist in profile.

Major Measurements and indices (n=13): TL 2.3-3.0 mm, HL 1.15-1.53 mm, HW 1.05-1.37 mm, SL 0.53-0.68 mm, FL 0.62-0.82 mm, CI 86-94, SI 47-51, FI 55-61. Head in full-face view with almost parallel sides (Fig. 7A), in profile distinctly impressed on vertex (Fig. 7B). Hypostoma bearing a large median process (Fig. 7C) (rarely the process poorly developed). Clypeus without a median longitudinal carina (rarely with an evanescent carina), with anterior margin hardly concave medially. Eye situated at about 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye 1.9-2.3 times as long as maximal diameter of eye. Frontal carina well-developed, horizontal, extending backward to 3/4 distance of head (Fig. 7A). Antennal scrobe deep and extensively overhung by frontal carina. Area around antennal insertion abruptly and deeply depressed. Antenna with 3-segmented club; terminal segment 1.1-1.3 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a small or evanescent denticle in front of basal angle. Promesonotal dome with an inconspicuous prominence on its posterior declivity (Fig. 7E); dorsal portion of the dome acutely produced laterally (Fig. 7D; but in various degrees). Mesopleuron sometimes with a weak or inconspicuous transverse impression. Propodeal spine 4-5 times as long as diameter of propodeal spiracle, usually blunt apically. Petiole 1.7-1.8 times as long as postpetiole (excluding helcium); petiolar node high, in posterior view emarginate at apex in various degrees. Postpetiole 1.7-2.0 times as broad as petiolar node, acutely produced laterally.

Frons irregularly reticulate, with enclosures punctured weakly and dull; dorsal and dorsolateral faces of occipital lobe reticulate, with smooth and shining enclosures; area between antennal scrobe and eye very weakly reticulate, with punctured and dull enclosures; ventrolateral face of occipital lobe

smooth and shining; dorsum of promesonotal dome weakly punctured and weakly shining, and with several transverse or irregular rugulae; lateral face of promesonotal dome and lower part of mesopleuron sometimes smooth and shining; dorsal and declivitous faces of propodeum smooth and shining; remainder of alitrunk weakly punctured and weakly shining; ventral faces of midcoxa and hindcoxa distinctly reticulate; lateral faces of petiole and postpetiole very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with very short appressed hairs (< 0.02 mm in length), which are much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer appressed to decumbent hairs. Body brown with darker head (especially its anterior part) and with lighter waist and gaster, or dark reddish-brown; flagella and tarsi lighter than alitrunk.

Minor Measurements and indices (n=13): TL 1.4-1.8 mm, HL 0.50-0.66 mm, HW 0.48-0.63 mm, SL 0.42-0.58 mm, AL 0.62-0.85 mm, FL 0.45-0.66 mm, CI 96-98, SI 87-96, FI 95-110. Head in full-face view slightly concave posteriorly (Fig. 7F); occipital carina evanescent dorsally on head. Clypeus sometimes with a median longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Frontal carina sometimes present as an evanescent rugula extending beyond midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape slightly extending beyond posterior border of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotum forming a low and relatively flat dome, with a pair of spines which are variable in length, blunt apically, and divergent from each other in anterior view; posterior declivity of the dome without a distinct prominence (Fig. 7G). Mesopleuron without a transverse impression. Propodeal spine straight or slightly curved, occasionally blunt at apex, usually 5 times (rarely much more than 5 times) as long as diameter of propodeal spiracle. Petiole 1.8-2.0 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole 1.5-1.7 times as broad as petiole.

Dorsal and lateral faces of head including clypeus punctured, or weakly reticulate with punctured enclosures; alitrunk punctured; lateral face of petiolar pedicel punctured very weakly and shining; dorsum of petiole, and postpetiole and gaster smooth and shining. Body yellowish-brown to brown, or dark brown with lighter mandible; flagella and legs lighter than alitrunk.

Variation Two relatively distinct colour forms are observed in both the subcastes; the "brown form" and "dark form" are more or less recognisable sympatrically in Poring and Gunong Rara, Sabah. All of the examined colonies from Halimun (W. Java), and also one colony collected from Lombok, are of the "dark form". Type series of this species seems to belong to the "brown form". However, I am at present unsuccessful in finding any other character correlated with this color variation. Therefore, I refrain from concluding their status, and tentatively treat them to be conspecific.

Recognition This species is easily recognised among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: promesonotum of the minor armed with a pair of blunt spines; frons of the major irregularly reticulate; hypostoma of the major bearing a stout (rarely poorly developed) median process; frontal carina of the major horizontal, and extensively

overhanging antennal scrobe. The close relationship between *P. aristotelis* and *P. hortensis* Forel and its possible relatives is inferred by their exceptional characteristics, *i.e.*, distinctly reticulate ventral faces of midcoxa and hindcoxa in the major.

Distribution Southern Malay Peninsula, Borneo, Sumatra, Java and Lombok (Figs. 59).

Bionomics This species inhabits well-developed forests from lowlands to hill areas (probably not exceeding 1000 m alt.). It nests in rotting twigs and wood blocks on the forest floor, and stores up a number of tiny seeds in the nest (Eg96-BOR-142, 144, 197, 205, 221, 235, 273, 317). I have never encountered colonies which include more than one dealate queen.

6. *Pheidole bugi* Wheeler (Fig. 8)

Pheidole bugi Wheeler, 1919: 66, major and minor (MCZ, Type 8947). Type locality: Sarawak, Borneo. Three syntypes (1 major and 2 minors) were examined, and the major was designated as the **lectotype**. Careful examination of the type material of *P. bugi* and Wheeler's original description suggest that the two minors belong to a species of the genus *Monomorium*.

Specimens examined BORNEO. Sabah, Malaysia: Tawau Hills Park, 2 minors (GC), KE, 1996. Brunei: Merimbun Heritage Park, 3 majors and 5 minors (Eg99-BOR-004). NANSEI IS., Japan. Shuri, Okinawa-jima, 1 major and 3 minors (Colony: A-7), K. Kishima leg., 1999. SOUTHERN CHINA. Hongkong: Tai Lung Farm, Sheung Shui, New Territory, 1 minor (GC), KE, 1999. Macau: Hac-Sa, Coloane I., 1 minor (GC), KE, 1999. MYEIK'S ARCHIPELAGO, Myanmar. Cat & Kitten I., 4 majors and 18 minors, Ecoswiss coll., 1999 (MZLS). SUMATRA, Indonesia. Maninjau, W. Sumatra, 10 minors, SNS; 27 km from Tapau to Painau, W. Sumatra, 1 minor, SNS; Padang, W. Sumatra, 1 minor, SNS; Teluk Bayur, nr. Padang, W. Sumatra, 2 majors, SNS. MENTAWAI IS., Indonesia. Pulau Sipora, 5 minors, SNS. LOMBOK, Indonesia. Selong, 11 majors and 12 minors (Eg98-LMB-1020, 1021).

Major Measurements and indices (n=4): TL 2.5 mm, HL 1.10-1.11 mm, HW 0.91-0.95 mm, SL 0.43-0.45 mm, FL 0.62 mm, CI 83-86, SI 47-49, FI 66-68. Head broadest at 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 8A), in profile slightly impressed on vertex (Fig. 8B). Hypostoma bearing three median processes (Fig. 8C). Clypeus without a median longitudinal carina, with anterior margin weakly concave medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye ca. 1.4 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Masticatory margin of mandible with apical and preapical teeth, and a distinct denticle in front of basal angle. Antenna with 3-segmented club; scape slightly extending beyond midlength of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotum forming a high dome, with an inconspicuous prominence on its posterior declivity (Fig. 8E); each dorsolateral portion of the dome produced outward (Fig. 8D). Mesopleuron without a distinct transverse impression. Propodeal spine triangular, 2.5-3 times as long as diameter of propodeal spiracle. Petiole 1.5-1.6 times as long as postpetiole (excluding helcium); petiolar node high, in posterior view slightly emarginate at apex. Postpetiole 1.4-1.5 times as broad as petiolar node, angulate laterally.

Frons longitudinally rugose; vertex, and dorsal and dorsolateral faces of occipital lobe reticulate, with enclosures punctured and dull or inconspicuously punctured; lateral face of occipital lobe covered with interrupted rugulae; dorsum of promesonotum reticulate, with punctured enclosures; lateral face of promesonotum weakly rugoso-punctured; lower part of mesopleuron smooth and shining in part; remainder of alitrunk, petiole and postpetiole punctured and dull; first gastral tergite

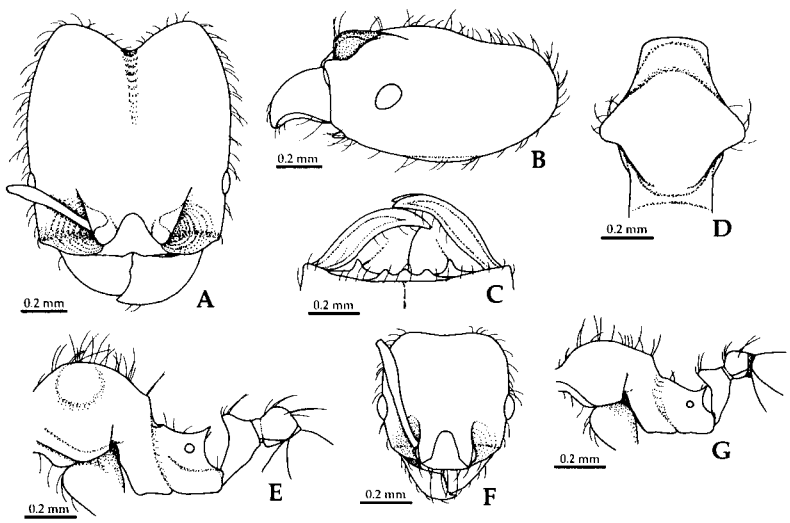

Fig. 8. ***Pheidole bugi*** **Wheeler (Eg99-BOR-004): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, promesonotum in dorsal view; E, same, alitrunk and waist in profile; F, minor, head in full-face view; G, same, alitrunk and waist in profile.**

weakly punctured around its articulation with postpetiole. Outer face of mandible sparsely covered with very short appressed hairs (< 0.03 mm in length), which are shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with longer decumbent hairs. Body yellowish-brown with darker mandible, clypeus and gaster.

Minor Measurements and indices (n=7): TL 1.6-1.7 mm, HL 0.50-0.55 mm, HW 0.45-0.49 mm, SL 0.40-0.44 mm, AL 0.63-0.70 mm, FL 0.43-0.48 mm, CI 89-93, SI 85-90, FI 93-99. Head in full-face view slightly concave posteriorly (Fig. 8F); occipital carina almost absent dorsally on head. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Clypeus with (occasionally without) a weak median longitudinal carina, with anterior margin in full-face view truncate medially. Antenna with 3-segmented club; scape hardly extending beyond posterior border of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotum in profile low, weakly convex dorsally, occasionally with a pair of inconspicuous tubercles, without a prominence on its posterior declivity (Fig. 8G). Mesopleuron without a distinct transverse impression. Propodeal spine triangular, almost twice as long as diameter of propodeal spiracle. Petiole ca. 1.9 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole 1.4-1.5 times as broad as petiolar node.

Clypeus smooth and shining, or slightly punctured; remainder of dorsum of head above subocular level punctured and dull; ventral face of head below subocular level smooth and shining in its anterior half, and punctured and dull in its posterior half; alitrunk punctured and dull; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole largely smooth and shining; gaster smooth and shining. Body yellowish-brown with a little darker gaster; legs a little lighter than alitrunk.

Recognition This small species is recognised among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: hypostoma of the major bearing three median processes; frontal carina and antennal scrobe of the major present only around antennal insertion; posterior declivity of promesonotal dome only with an inconspicuous prominence in the major; alitrunk of the major largely sculptured, and head above subocular level and alitrunk of the minor punctured. In general habitus this species is very similar to *P. rabo* among Bornean congeners, but easily distinguished from the latter where lateral two of the three median processes on hypostoma of the major are much larger than medianmost one, and head below subocular level of the minor is punctured. The major of this species is also similar to that of *P. simoni* Emery (for redescription of the lectotype of *P. simoni*, see Eguchi, 2001), but in the latter eye of the major smaller, and posterior declivity of promesonotum of the major with a conspicuous prominence.

I borrowed from MHNG six syntypes of *P. rinae* var. *mala* which was described from Java by Forel (1911b: 205) (of the 3 majors and 3 minors examined, a major is designated here as the **lectotype**). This form and *P. bugi* are very similar to each other, and probably conspecific. But I refrain here from concluding their status since no true minors of *P. bugi* are included in the type material and the direct comparison of the minor of the two forms is impossible (body sculpture is occasionally very important in the minors of small-sized species). Colony-based specimens from various localities within the Indo-Malayan subregion should be examined prior to final decision.

Distribution Japan (Okinawa I.), S. China, Borneo, Sumatra, Mentawai Is. and Lombok. This is the first record of the species from Japan (Japanese name: Nanyô-tenkoku-oozuari).

Bionomics This species seems to inhabit open lands and forest edges. Thus it has probably widened its range at least partly through human commerces.

7. *Pheidole butteli* Forel (Fig. 9)

Pheidole butteli Forel, 1913: 36, major, minor, queen and male (MHNG). Type locality: Tandjong Slamat, Sumatra. Lectotype designation and redescription of type material: Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia: Gunong Rara, 4 majors, 14 minors, 2 queens and 1 male (Eg97-BOR-524); nr. Kota Kinabalu, 7 majors and 16 minors (Eg96-BOR-104); Mahua Waterfall area, 1 major and 1 minor (MA00-HO-034); Pulau Gaya (Tunku Abdul Rahman Park, off the coast of Kota Kinabalu), 5 majors and 11 minors (GC), SKY, 1995. Sarawak, Malaysia: Lambir Hills N. P., 5 majors, 9 minors and 1 queen (Eg98-BOR-830). Brunei: Merimbun Heritage Park, 4 majors, 10 minors and 2 queens (Eg99-BOR-085). MALAY PENINSULA. Malaysia: Ulu Gombak, 2 majors, 3 minors and 1 male (FI92MG-542). SUMATRA, Indonesia. Lubuk Gadang, W. Sumatra, 1 major and 9 minors, SNS; Ulu Gadut, nr. Padang, W. Sumatra, 4 majors, 7 minors and 2 queens (FI97-343, 411, 415). JAVA, Indonesia. Kebun Raya, Bogor, 2 majors, 7 minors and 1 queen (31, 10/13b), MK, 1996 and 1999; Ujung Kulon, W. Java, 4 majors, 4 minors, 4 queens and 1 male (FI95-546, 732, 810).

Major Measurements and indices (n=6): TL 2.0-2.4 mm, HL 0.88-1.02 mm, HW 0.76-0.87 mm, SL 0.42-0.48 mm, FL 0.55-0.64 mm, CI 82-88, SI 53-59, FI 70-78. Head broadest about 1/2-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 9A), in profile not or slightly impressed on vertex (Fig. 9B). Hypostoma bearing three median processes (Fig. 9C). Clypeus without a median longitudinal carina, with anterior margin weakly emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.6 times as long as maximal diameter of eye. Frontal carina almost absent, or inconspicuous and extending

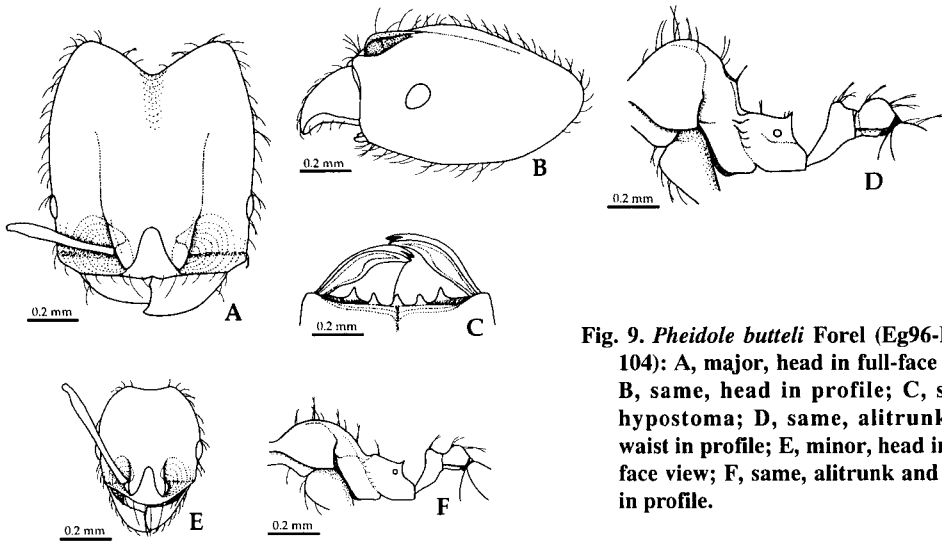

Fig. 9. *Pheidole butteli* Forel (Eg96-BOR-104): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.

backward to about 2/3 of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about midlength of head, or slightly beyond there; terminal segment 1.1-1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotum forming a high dome, with an inconspicuous prominence on its posterior declivity (Fig. 9D); each dorsolateral portion of the dome weakly produced outward. Mesopleuron sometimes divided by a weak transverse impression into two parts, of which lower part is margined dorsally. Propodeal spine triangular or horn-like, 2-2.5 times as long as diameter of propodeal spiracle. Petiole 1.6-1.8 times as long as postpetiole (excluding helcium); petiolar node in posterior view hardly or not emarginate at apex. Postpetiole 1.7-1.8 times as broad as petiolar node.

Dorsum of head excluding occipital lobe longitudinally rugose, with smooth and shining interspaces; dorsal and dorsolateral faces of occipital lobe reticulate or rugoso-reticulate, with enclosures smooth and shining or very weakly punctured; lateral face of occipital lobe weakly rugoso-reticulate; dorsum of promesonotal dome largely smooth and shining, or very weakly sculptured; anterior and lateral faces of the dome largely smooth and shining; remainder of alitrunk and waist weakly punctured at least partly; first gastral tergite weakly punctured around its articulation with postpetiole. Outer face of mandible sparsely covered with appressed hairs, which are 0.02-0.05 mm in length and shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body brown to reddish-brown, with a little darker gaster; flagella and legs a little lighter than alitrunk.

Minor Measurements and indices (n=5): TL 1.4-1.6 mm, HL 0.45-0.50 mm, HW 0.39-0.43 mm, SL 0.43-0.50 mm, AL 0.62-0.69 mm, FL 0.46-0.54 mm, CI 84-89, SI 104-119, FI 114-129. Head in full-face view narrowed behind eye, with almost flat or weakly concave posterior margin (Fig. 9E); occipital carina evanescent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.8-0.9 times as long as

maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by its 1/5 length; terminal segment ca. 1.1 times as long as preceding two segments together. Promesonotum convex, without any prominence on its posterior declivity (Fig. 9F). Mesopleuron sometimes with a transverse impression. Propodeal spine 1.5-2 times as long as diameter of propodeal spiracle. Petiole ca. 1.8 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole in dorsal view subhexagonal, 1.4-1.6 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; remainder of alitrunk weakly punctured at least partly; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body yellowish-brown (alitrunk sometimes a little lighter than head and gaster); antennae and legs a little lighter than alitrunk.

Recognition This species is recognised among Indo-Malayan congeners by a combination of the following characteristics: hypostoma of the major bearing three median processes (Fig. 9C); frontal carina of the major inconspicuous; promesonotal dome highly raised in the major; lower part of mesopleuron margined dorsally in the major (Figs. 9D); head and promesonotum of the minor smooth and shining. *P. butteli* is separated from the most similar *P. tawauensis* sp. nov. in which frontal lobe of the major is relatively large and erect (Fig. 50B), and occipital carina of the minor is stronger (Fig. 50D) (see under *P. tawauensis* sp. nov.).

Distribution Southern Malay Peninsula, Borneo, Sumatra and Java.

Bionomics This species inhabits well-developed forests in lowlands and hill areas. Two colonies each (Eg97-BOR-524, Eg99-BOR-085) included at least two dealate queens.

8. *Pheidole cariniceps* sp. nov. (Fig. 10)

Holotype Major, colony: Eg98-BOR-840, Logging area nr. Ranau, Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1998, deposited in UMS.

Paratypes 9 majors, 15 minors and 5 males from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 1 minor, CB, 1998-1999; Poring, ca. 600 m alt., 2 majors and 6 minors (06Q44B6), TK; Sepilok forest, 1 major and 4 minors (Eg97-BOR-420); Tawau Hills Park, 1 major (GC), KE, 1996 / 1 major and 19 minors (GC; soil-12), SKY, 1996. Sarawak, Malaysia: Bt. Entimau (390 m alt.), 5 minors (GC), Mahmud leg., 1994; Lambir Hills N. P., 1 major, 6 minors and 1 queen (Eg98-BOR-801) / 1 major and 40 minors (GC), SKY, 1993 and 1994. Brunei: Belalong Forest Section, 3 majors, 4 minors and 1 queen (Eg99-BOR-218); Merimbun Heritage Park, 17 majors, 34 minors and 6 queens (Eg99-BOR-049, 050, 063, 133, 135, 137, 561, 562, 579). E. Kalimantan, Indonesia: Bukit Soehart (UNMUL forest), 2 minors (GC), SKY, 1992; Kutai N. P., 4 majors and 11 minors (GC), SKY, 1993. MALAY PENINSULA. Malaysia: Ulu Gombak, 2 majors, 3 minors and 1 male (FI96-725, FI99-90). SUMATRA, Indonesia. Ulu Gadut, Padang, W. Sumatra, 2 majors and 4 minors (FI96-107) / 12 minors, SNS; Maninjau, W. Sumatra, 1 minor (GC), SNS; Sako nr. Tapan, W. Sumatra, 1 minor, SNS.

Major Measurements and indices (n=10): TL 3.7-4.6 mm, HL 1.57-1.85 mm, HW 1.45-1.63 mm, SL 0.83-0.88 mm, FL 1.27-1.38 mm, CI 88-93, SI 54-58, FI 83-89. Head broadest at 1/2-3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 10A), in profile gently impressed on vertex (Fig. 10B). Hypostoma without distinct median processes. Clypeus rarely with a median

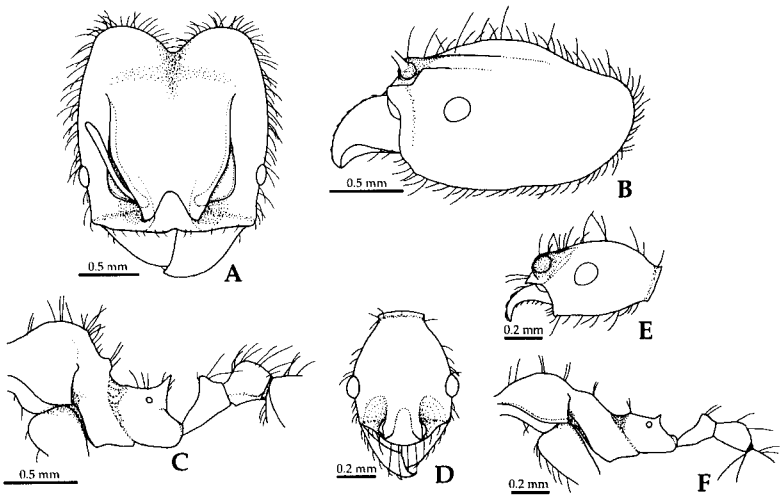

Fig. 10. ***Pheidole cariniceps*** **sp. nov. (type material: Eg98-BOR-840): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, head in profile; F, same, alitrunk and waist in profile.**

longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.7 times as long as maximal diameter of eye. Frontal carina distinct, extending backward to about 2/3 distance of head. Antennal scrobe shallow, running along frontal carina, margined below by a distinct carina along its anterior half (Fig. 10A). Antenna with 3-segmented club; scape extending backward to about 3/5 distance of head; terminal segment ca. 0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 10C); the prominence in anterior view not or very weakly concave medially. Mesopleuron without a distinct transverse impression. Propodeal spine elongate-triangular, with broad base, ca. 3.5 times as long as diameter of propodeal spiracle (Fig. 10C). Petiole cuneiform, 1.3-1.5 times as long as postpetiole (excluding helcium); petiolar node in posterior view weakly emarginate at apex. Postpetiole in dorsal view subpentagonal, 2.1-2.3 times as broad as petiolar node.

Frons longitudinally rugose, with very weakly punctured interspaces; vertex and dorsal and lateral faces of occipital lobe rugoso-reticulate, with very weakly punctured enclosures; promesonotum smooth and shining with transverse rugulae dorsally; mesopleuron and lateral face of propodeum weakly rugoso-reticulate, with distinctly punctured enclosures; petiole (excluding smooth anterodorsal face), postpetiole and anterior part of first gastral tergite weakly punctured. Outer face of mandible covered with appressed hairs, which are 0.04-0.08 mm in length and much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body yellowish-brown to reddish-brown, with much darker gaster; legs a little lighter than alitrunk.

Minor Measurements and indices (n=12): TL 2.0-2.4 mm, HL 0.59-0.74 mm, HW 0.46-0.55 mm,

SL 0.81-0.97 mm, AL 0.88-1.10 mm, FL 0.84-1.08 mm, CI 73-77, SI 170-186, FI 183-200. Head in full-face view oval; occipital carina forming a well-developed flange (Fig. 10D, E). Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate medially. Eyes situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.8-0.9 times as long as preceding two segments together. Promesonotal dome with a gentle prominence on its posterior declivity (Fig. 10F). Mesopleuron without a transverse impression. Propodeal spine elongate-triangular, ca. 1.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.2-1.3 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, 1.8-2.2 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; remainder of alitrunk punctured; lateral faces of petiole and postpetiole weakly punctured; dorsa of petiole and postpetiole, and gaster almost smooth and shining. Prominence on posterior declivity of promesonotum, and dorsum of propodeum each bearing a pair of standing hairs (Fig. 10F). Body yellowish-brown with a little lighter alitrunk; legs sometimes a little lighter than alitrunk.

Recognition The closest relative of this species is the sympatric *P. aglae* Forel, but in the latter antennal scrobe of the major is not margined below by distinct carina (Fig. 4A); propodeal spine of the major has narrow base (Fig. 4D); and prominence on posterior declivity of promesonotum, and dorsum of propodeum each bear more than two pairs of erect or suberect hairs in the minor (Fig. 4G).

Distribution Southern Malay Peninsula, Borneo and Sumatra.

Bionomics This species inhabits well-developed lowland and hill forests, and nests in the soil.

9. *Pheidole cingulata* (Fr. Smith)

Atta cingulata Fr. Smith, 1857: 77, major and minor. Type locality: Borneo. Type material not examined.
Aphaenogaster cingulata: Dalla Torre, 1893: 102.
Pheidole cingulata: Emery, 1915a: 69.

According to B. Bolton (pers. com., 2000) "the types of *P. cingulata* are not here [BM], not at Oxford, and are presumed lost". Therefore I can not give any additional information on this species. The original description (Fr. Smith, 1857) is cited below.

"Worker major. Length 1 $^{3}/_{4}$ line [1 line=2.1 mm]. Head very large, ferruginous, the antennae paler; eyes very small, placed at the sides of the head a little before the middle. Thorax: pale ferruginous, very convex or globose anteriorly, much narrower behind, with two short acute spines on the metathorax; legs pale rufo-testaceous. Abdomen: ovate, with the base truncated, with a fuscous ring in the middle; the nodes of the peduncle globose.

Worker minor. About 1 line in length. The head much smaller and more elongate; in colour, resembling the larger worker, and equally smooth and shining; the abdomen with a fuscous ring in the middle.

Hab. Borneo (Sarawak)."

10. ***Pheidole clypeocornis*** sp. nov. (Fig. 11)

Holotype Major, colony: Eg96-BOR-035, Tawau Hills Park, Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1996, deposited in UMS.

Paratypes 18 majors, 22 minors, 1 teneral queen and 2 males from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 36 majors, 63 minors, 3 queens and 2 males (Eg96-BOR-136, 146, 161, 168, 176, 180, 190, 196, 208, 209, 222, 230, 233, 236); Gunong Rara, 21 majors, 33 minors and 1 male (Eg96-BOR-329, 344, 345, 347, 354, 356, 373); Mahua Waterfall area, 3 majors and 3 minors (Eg00-BOR-130); Poring, ca. 450-500 m alt., 10 majors, 19 minors and 1 male (Eg96-BOR-264, 274, 275, 278) / ca. 500-550 m alt., 3 majors and 4 minors (Eg96-BOR-303) / ca. 600 m alt., 43 majors, 60 minors, 3 queens and 3 males (6X2506-1-Ea, 6X2506-2-Ea, 6X2506-III-9, 6X2606-2-11, 6X2606-2I-5, 6X2606-2I-d2, 6X2606-2II-14, 6X2606-2II-6, 6X2606-2II-10, 6X2606-2III-12, 6X2606-2III-13, 6X2606-2III-15, 6X2606-2IV-16, 6X2606-3III-4, 6X2606-4I-2, 6X2606-4II-4, 6X2606-4IV-10, 6X2606-4IV-11, 6X2606-5-6, 6X2906-7-Ca, 6X2906-8-Ca, 6X3006-11-7, 6XI1006-17-2b, 6XI1006-17-Bc, 6XI1006-19-Ac, 7III2606-29-Da), TK / ca. 900 m alt., 18 majors and 21 minors (6XI2710-1-Cc, 6XI2810-2-12, 6XI2810-2-Bb, 6XI2810-2-Fb, 7IV0310-5-Fa, 7IV0310-5-Ha, 7IV0510-7-Aa; 09Q11S4; 508A), TK; Sepilok forest, 13 majors, 24 minors and 1 male (Eg97-BOR-427, 440, 442, 446, 450); Tawau Hills Park, 2 majors and 4 minors (Eg96-BOR-032). Sarawak, Malaysia: Bako N. P., 2 majors, 2 minors and 1 male (FI96-538). Brunei: Merimbun Heritage Park, 31 majors, 46 minors, 8 queens and 14 males (Eg99-BOR-006, 036, 082, 090, 094, 106, 109, 119, 124, 513, 592, 596, 597, 610). MALAY PENINSULA. Malaysia: Ulu Gombak, 2 majors and 6 minors (FI96-649). SUMATRA, Indonesia. Bt. Sabalah, W. Sumatra, 3 majors (FI92-234); Sitiung, W. Sumatra, 5 majors and 3 minors (FI93-253, 261). JAVA, Indonesia: G. Halimun, 5 majors, 6 minors and 1 male (FI96-277; FI98-340, 396). LOMBOK, Indonesia: Santong, N. Lombok, 9 majors, 13 minors, 5 queens and 2 males (Eg98-LMB-1065, 1066, 1067); nr. Senaru, N. Lombok, 5 majors, 6 minors and 2 males (Eg98-LMB-1048); Tetebatu, C. Lombok, 8 majors and 10 minors (Eg98-LMB-1035, 1037).

Major Measurements and indices (n=8): TL 1.8-2.3 mm, HL 0.78-0.93 mm, HW 0.69-0.80 mm, SL 0.34-0.38 mm, FL 0.41-0.48 mm, CI 86-92, SI 47-51, FI 59-63. Head broadest at about 3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)), in profile weakly impressed on vertex (Fig. 11). Hypostoma bearing one distinct median process (rarely it is rather reduced). Clypeus without a median longitudinal carina, with anterior margin very weakly concave medially; lateral part of clypeus developed into a horn (Fig. 11). Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.6 times as long as maximal diameter of eye. Frontal carina horizontal, extending backward to about 2/3 distance of head. Antennal scrobe narrowly overhung by frontal carina. Antenna with 3-segmented club; scape extending backward to 5/9-3/5 distance of head; terminal segment 1.3-1.4 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and two denticles in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity; each dorsolateral portion of the dome well and roundly produced outward. Mesopleuron divided by a weak transverse impression into upper and lower parts. Propodeal spine triangular or elongate-triangular, ca. 1.5 times as long as diameter of propodeal spiracle. Petiole 1.5-1.7 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole 1.4-1.8 times as broad as petiolar node.

Frons longitudinally rugose, with smooth and shining interspaces; dorsal and dorsolateral faces of occipital lobe reticulate with enclosures smooth and shining, or rarely punctured very weakly; outer face of mandible weakly rugose only laterally near its base; dorsum of promesonotal dome smooth

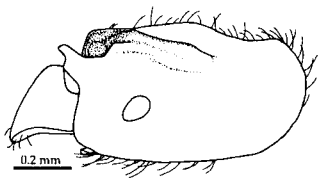

Fig. 11. *Pheidole clypeocornis* sp. nov. (type material: Eg96-BOR-035), major, head in profile.

and shining with several transverse rugulae; lateral face of the dome and lower part of mesopleuron smooth and shining; upper part of mesopleuron weakly punctured; propodeum smooth and shining over the surface, or weakly punctured partly on lateral face; ventral faces of midcoxa and hindcoxa distinctly reticulate; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Outer face of mandible covered with very short appressed hairs (≤ 0.02 mm in length), which are much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer appressed to decumbent hairs. Body yellowish-brown, sometimes with darker mandible, clypeus and gaster; legs a little lighter than alitrunk.

Minor Measurements and indices (n=8): TL 1.3 mm; HL 0.40-0.43 mm, HW 0.38-0.40 mm, SL 0.33-0.35 mm, AL 0.50-0.54 mm, FL 0.34-0.38 mm, CI 92-96, SI 85-91, FI 88-96. It is at present impossible to separate the minor of this species from that of *P. hortensis* Forel in external morphology.

Recognition *P. clypeocornis* sp. nov. is closely related to *P. maculifrons* Wheeler (known only from the Philippines), *P. rugifera* sp. nov., *P. tenebricosa* sp. nov., *P. kikutai* sp. nov. and *P. hortensis* Forel, and all these are recognised among the congeners by the combination of the characteristics noted under *P. hortensis*. Among the species known from Borneo the closest relative is *P. hortensis*, in which each lateral part of clypeus of the major never develops into a horn (Fig. 20B).

Distribution Southern Malay Peninsula, Borneo, Sumatra, Java and Lombok.

Bionomics This species nests in rotting wood, and stores up a number of tiny seeds in its nest (Eg96-BOR-347).

11. *Pheidole comata* Fr. Smith (Fig. 12)

Pheidole comata Fr. Smith, 1858b: 176, major (BMNH). Type locality: Sarawak, Borneo. 1 syntype (major) was examined.

Pheidole multicoma Eguchi, 1999: 100, major and minor (UMS, MNHA). Type locality: Sayap Kinabalu (ca. 1000 m alt.), Sabah, Borneo. Junior synonym of *P. comata*: Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia. Mahua Waterfall area, 14 majors, 16 minors and 2 queens (Eg00-BOR-101); Poring, 1 major (GC), Y. Hashimoto leg., 1995 / ca. 550 m alt., 1 major and 1 minor (GC), SKY, 1995; Sayap Kinabalu, 1 major and 4 minors (Eg96-BOR-058) / 1 major and 1 minor (GC), TK, 1994. MALAY PENINSULA. Malaysia: Bunga Buah (1100 m alt.), nr Genting Highlands, 3 majors and 6 minors (FI99-209, 210).

Major Measurements and indices (n=9): TL 6.8-8.3 mm, HL 2.75-3.07 mm, HW 2.59-2.86 mm, SL 1.70-1.96 mm, FL 2.83-3.29 mm, CI 88-101, SI 60-75, FI 101-123. Head broadest at 3/5-3/4 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head in full-face view with a median emargination from which a shallow longitudinal impression extends to midlength of head (Fig. 12A); head in profile not impressed on vertex (Fig. 12B). Hypostoma lacking median

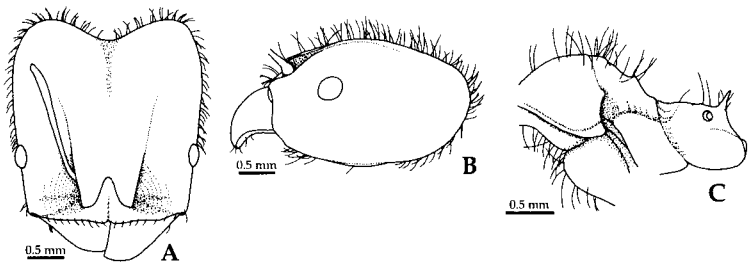

Fig. 12. ***Pheidole comata*** **Fr. Smith (HN-148): A, major, head in full-face view; B, same, head in profile; C, alitrunk in profile.**

processes. Clypeus with a median longitudinal carina, with anterior margin hardly emarginate medially. Eye situated around 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.8 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna without conspicuous club; scape extending backward to 7/10-3/4 distance of head. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 12C); the prominence in anterior view not or very weakly concave medially. Mesopleuron with an indistinct transverse impression. Propodeal spine corniform, 2-3 times as long as diameter of propodeal spiracle. Petiole in profile cuneiform, 1.1-1.2 times as long as postpetiole, with ill-defined node of which apex is in posterior view weakly or very weakly concave. Postpetiole in dorsal view subpentagonal, 2.3-2.4 times as broad as petiole.

Frons and gena longitudinally rugose; vertex and dorsal and dorsolateral faces of occipital lobe rugoso-reticulate, with enclosures weakly punctured and weakly shining; lateral face of occipital lobe densely rugose and dull; promesonotal dome in dorsal view transversely rugose, with smooth and shining interspaces; mesopleuron and lateral face of propodeum weakly rugose with interspaces punctured very weakly, or lower part of mesopleuron largely smooth and shining; petiole (excluding smooth and shining anterodorsal face), postpetiole and first gastral tergite rugoso-punctured and dull. Head densely bearing standing hairs over the surface; outer face of mandible sparsely covered with appressed hairs, which are 0.03-0.10 mm in length and shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with longer decumbent hairs; dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing ca. 20 or more standing hairs. Body dark reddish-brown to blackish-brown; flagella and legs lighter than alitrunk.

Minor Measurements and indices (n=10): TL 4.1-5.1 mm, HL 1.23-1.44 mm, HW 0.75-0.93 mm, SL 1.88-2.21 mm, AL 1.73-2.01 mm, FL 2.33-2.83 mm, CI 61-65, SI 229-270, FI 289-337. At present it is impossible to separate this species from *P. longipes* (Fr. Smith) by any morphological characteristics in the minor.

Recognition This species is closely related to *P. longipes* (Fr. Smith) and *P. montana* Eguchi, and all these are peculiar among Indo-Chinese and Indo-Malayan congeners in the following characteristics: antenna of both the subcastes lacking conspicuous club; posterior part of head of the minor forming elongate neck. The major of *P. comata* is distinguished from that of *P. longipes* by the

following characteristics observed in the former: lateral face of head behind eye distinctly rugose; head bearing many standing hairs not only dorsally but also laterally; in profile dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing ca. 20 or more standing hairs. This species is also well distinguished from *P. montana* in which propodeal spine is much longer and body is lighter in colour in both the subcastes.

Distribution Southern Malay Peninsula and Borneo.

Bionomics This species inhabits well-developed forests in hill areas up to ca. 1100 m alt, and sympatric with *P. longipes* in Poring (ca. 600 m alt.). The colony collected in Mahua Waterfall area (Eg00-BOR-101) nests in a fallen rotting log.

12. *Pheidole deltea* sp. nov. (Fig. 13)

Holotype Major, colony: Eg96-BOR-374, Gunong Rara (4°58'N 117°8'E, ca. 250 m alt.), Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1996, deposited in UMS.

Paratypes 8 majors, 12 minors and 5 queens from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 2 majors, 19 minors and 1 queen (Eg96-BOR-189); Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Gunong Rara, 5 majors, 16 minors and 1 queen (Eg96-BOR-339); Mahua Waterfall area, 1 major and 1 minor (MA00-HO-008), HO, 2000 / 15 majors, 18 minors, 2 queens and 2 males (Eg00-BOR-116, 119, 125, 128); Poring, 1200 m alt., 3 majors, 4 minors and 1 queen (B119), TK / 1530 m alt. (East Ridge), 1 minor (code EW-2/3), CB, 1995; Tawau Hills Park, 10 majors, 33 minors and 2 queens (Eg96-BOR-015, 040). SUMATRA, Indonesia. Ulu Gadut, nr. Padang, W. Sumatra, 1 major and 2 minors (FI97-396). JAVA, Indonesia. G. Halimun, 3 majors, 6 minors and 2 queens (FI98-362, 368). BALI, Indonesia. Kebun Raya, 1 major and 1 minor (FI94-138).

Major Measurements and indices (n=9): TL 1.7-2.5 mm, HL 0.80-1.24 mm, HW 0.74-1.13 mm, SL 0.39-0.54 mm, FL 0.46-0.71 mm, CI 90-95, SI 46-54, FI 59-64. Head broadest at 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 13A), in profile not or slightly impressed on vertex (Fig. 13B). Hypostoma with three median processes, of which medianmost one is sometimes poorly developed (as seen in the type material). Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 3/10-1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.7 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to 1/2-3/5 of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with an inconspicuous prominence on its posterior declivity (Fig. 13C). Mesopleuron with an inconspicuous transverse impression. Dorsal outline of propodeum almost continuous and straight in profile (Fig. 13C); propodeal spine broadly based, 2.5-3.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.1-1.3 times as long as postpetiole (excluding helcium); petiolar node in posterior view not or slightly emarginate at apex. Postpetiole in dorsal view subhexagonal, 1.8-2.2 times as broad as petiolar node.

Dorsal and lateral faces of head excluding vertex and occipital lobe longitudinally rugose; remainder of head smooth and shining; promesonotal dome smooth and shining, sometimes with several rugulae dorsally; upper part of mesopleuron and lateral face of propodeum punctured largely;

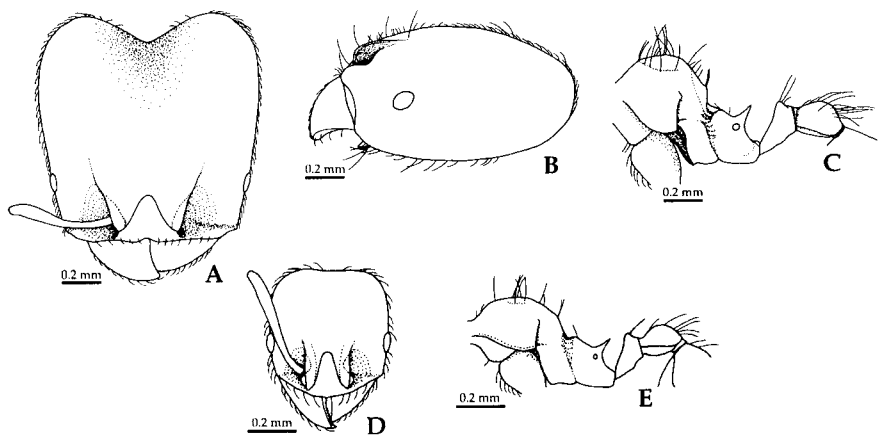

Fig. 13. ***Pheidole deltea*** **sp. nov. (type material: Eg96-BOR-374): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

lower part of mesopleuron smooth and shining largely; lateral faces of petiole and postpetiole very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible covered with appressed to decumbent hairs, which are 0.04-0.09 mm in length and as long as, or a little longer than, distance between piligerous punctures. Body light yellowish-brown, yellowish-brown or brown, with a little darker mandibles and clypeus (sometimes gaster is also darker than head and alitrunk); flagella and legs sometimes a little lighter than alitrunk.

Minor Measurements and indices (n=9): TL 1.3-1.6 mm, HL 0.43-0.54 mm, HW 0.41-0.50 mm, SL 0.37-0.47 mm, AL 0.56-0.69 mm, FL 0.38-0.49 mm, CI 93-98, SI 88-97, FI 90-99. Head in full-face view almost straight or slightly concave posteriorly (Fig. 13D); occipital carina almost absent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eyes situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.8-0.9 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape slightly extending beyond posterior border of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotal dome without a prominence on its posterior declivity (Fig. 13E). Mesopleuron without a distinct transverse impression. Dorsal outline of propodeum almost continuous and straight in profile (Fig. 13E); propodeal spine elongate-triangular, 3.5-4 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.2 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole 1.8-2.2 times as broad as petiolar node.

Dorsolateral face of head slightly rugoso-reticulate; remainder of head including clypeus smooth and shining; promesonotum smooth and shining; mesopleuron and lateral face of propodeum punctured; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body light yellowish-brown to yellowish-brown; antennae and legs a little lighter than alitrunk.

Variation Inter-colonial size variation has been observed. Majors from Eg96-BOR-374 (type

material, collected from Gunong Rara) and Eg96-BOR-189 (Danum Valley) are relatively large in size, and their hypostoma has three median processes, of which medianmost one is much reduced

Recognition This relatively small-sized species is recognised among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: occipital lobe of the major smooth and shining; posterior declivity of promesonotal dome lacking a distinct prominence in both the subcastes (Fig. 13C, E); dorsal outline of propodeum almost continuous and straight in profile in both the subcastes (Fig. 13C, E); propodeal spine of the minor elongate-triangular, 3.5-4 times as long as diameter of propodeal spiracle (Fig. 13C, E).

Distribution Borneo, Sumatra, Java and Bali.

13. *Pheidole elisae* Emery (Fig. 14)

Pheidole elisae Emery, 1900: 686, major (MCSN). Type locality: Engano. One syntype was examined.

Pheidole elisae var. *nenia* Forel, 1913: 30, major and minor (MHNG). Type locality: Sumatra. Revised status as subspecies: Bolton, 1995. Lectotype designation: Eguchi, 2001. **New synonymy**.

Specimens examined BORNEO. Sabah, Malaysia: Poring, 450-500 m alt., 3 majors and 5 minors (Eg96-BOR-287) / 550 m alt., 8 majors (GC), SKY, 1995 / 600 m alt., 12 majors, 19 minors, 3 queens and 2 males (528; 6XII1006-S5-2, 6XII1006-S5-12, 6XII1006-S5-44, 6XII1206-S6-3, 6XII1206-S6-28 and 6XII1206-S6-29), TK. Brunei: Belalong Forest Section, 5 majors, 5 minors and 1 queen (Eg99-BOR-203, 213); Merimbun Heritage Park, 7 majors and 8 minors (Eg99-BOR-073, 077). MALAY PENINSULA. Malaysia: Ulu Gombak, 4 majors, 6 minors and 1 male (FI96-651, 673). SUMATRA, Indonesia. Padang, W. Sumatra, 1 major and 1 minor (4/28a), MK, 1998; Bt. Sabalah, W. Sumatra, 2 majors, 3 minors and 3 males (FI92-232); Sipisang, nr. Padang, W. Sumatra, 2 majors, 5 minors, 1 queen and 1 male (FI96-128); Sukarami, nr. Padang, W. Sumatra, 6 majors and 9 minors (FI92-58, 62, 85; FI96-175) / 2 majors and 5 minors (9/29a), MK, 1999; Ulu Gadut, nr. Padang, W. Sumatra, 6 majors, 8 minors, 1 queen and 4 males (FI96-96; FI97-362, 363). JAVA, Indonesia. Kebun Raya, Bogor, 3 majors and 10 minors (FI92-341); G. Halimun, 6 majors and 7 minors (FI96-359; FI98-312, 370, 397) / 2 majors and 5 minors (10/17d), MK, 1999.

Major Measurements and indices (n=5): TL 2.5-2.7 mm, HL 1.24-1.35 mm, HW 1.24-1.35 mm, SL 0.55-0.58 mm, FL 0.44-0.82 mm, CI 88-91, SI 48-50, FI 66-70. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 14A), in profile not impressed on vertex (Fig. 14B). Hypostoma bearing a pair of small median processes. Clypeus without a median longitudinal carina, with anterior margin distinctly emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.7 times as long as maximal diameter of eye; eight ommatidia present on longest axis of eye. Frontal carina inconspicuous, extending backward to 3/5-2/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; antennal scape slightly extending beyond midlength of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, without a conspicuous denticle in front of basal angle. Promesonotum forming a high dome, without a prominence on its posterior declivity (Fig. 14C); each dorsolateral portion of the dome not produced outward. Mesopleuron divided by a transverse impression into two parts, of which lower part is distinctly margined dorsally. Propodeal spine elongate-triangular or horn-like, 2-2.5 times as long as diameter of propodeal spiracle. Petiole 1.9-2.0 times as long as postpetiole (excluding helcium); petiolar node high (Fig. 14C), in posterior view not emarginate at apex. Postpetiole high, 1.5-1.6 times as broad as petiolar node.

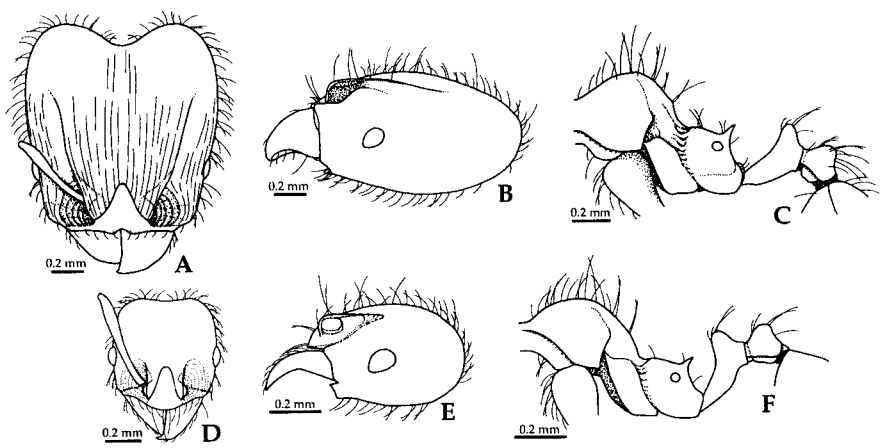

Fig. 14. ***Pheidole elisae*** **Emery (Eg96-BOR-287): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, head in profile; F, same, alitrunk and waist in profile.**

Dorsum of head, excluding occipital lobe longitudinally rugose, with smooth and shining interspaces; occipital lobe smooth and shining over the surface (Fig. 14A); promesonotum smooth and shining, with several weak rugulae dorsally; upper part of mesopleuron and lateral side of propodeum weakly rugoso-reticulate; lower part of mesopleuron largely smooth and shining; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Outer face of mandible sparsely covered with short appressed to decumbent hairs, which are 0.05-0.07 mm in length and almost as long as, or shorter than, distance between piligerous punctures. Body yellowish-brown or brown, with darker gaster (in majors collected in Merimbun and Belalong mandible, clypeus and dorsum of alitrunk and gaster are darker than the other part of body); flagella and legs sometimes a little lighter than alitrunk.

Minor Measurements and indices (n=5): TL 1.7-1.9 mm, HL 0.53-0.62 mm, HW 0.50-0.58 mm, SL 0.49-0.54 mm, AL 0.72-0.83 mm, FL 0.58-0.66 mm, CI 91-96, SI 93-98, FI 112-115. Head in full-face view almost flat posteriorly (Fig. 14D); occipital carina almost absent dorsally on head. Clypeus frequently with a weak median longitudinal carina, with anterior margin in full-face view truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye ca. 0.9 times as long as maximal diameter of eye (Fig. 14E); 6-7 ommatidia present on longest axis of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by its 1/6 length; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotal dome without any prominence on its posterior declivity (Fig. 14F). Mesopleuron divided by a transverse impression into two parts, of which lower part is distinctly margined dorsally. Propodeal spine triangular, 1.5-2 times as long as diameter of propodeal spiracle. Petiole 1.9-2.0 times as long as postpetiole (excluding helcium); petiolar node high (Fig. 14F), in posterior view not emarginate at apex. Postpetiole high, 1.3-1.5 times as broad as petiolar node.

Clypeus smooth and shining; remainder of head largely smooth and shining, but sometimes with

several evanescent rugulae on its dorsum; promesonotum smooth and shining; mesopleuron and lateral face of propodeum slightly punctured at least partly; petiole and postpetiole largely smooth and shining; gaster smooth and shining. Body brown with lighter alitrunk (or lateral face of alitrunk); antennae and legs sometimes a little lighter than alitrunk.

Variation Median processes on hypostoma frequently poorly developed in majors collected from Sumatra.

Recognition *P. elisae* is closely related to *P. sauberi* Forel, *P. sarawakana* Forel and *P. tandjongensis* Forel. They are recognised among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: petiolar node highly prominent dorsally in both the subcastes; lower part of mesopleuron margined dorsally in both the subcastes; hypostoma of the major with a pair of median processes. Three of the four species, *i.e.*, *P. elisae*, *P. sauberi* and *P. sarawakana*, are sympatric in Poring and Danum Valley, Borneo. In *P. sauberi* majors dorsum of head is completely covered with longitudinal rugulae (Fig. 14A); and in *P. sarawakana* eye is smaller in both the subcastes (4-5 ommatidia present on longest axis of eye in the major, and four ommatidia in the minor). The difference between *P. elisae* and *P. sarawakana* in the number of ommatidia is, however, less distinct in Sumatra.

Distribution Southern Malay Peninsula, Borneo, Sumatra, Engano and Java.

Bionomics This species inhabits well-developed forests in lowlands and hill areas, and usually nests in rotting wood.

14. *Pheidole fantasia* Chapman (Fig. 15)

Pheidole fantasia Chapman, 1963: 255-258, major, minor and queen (MCZ, Type 31796). Type locality: Horns of Negros (3600 ft), Philippine Is. Eleven syntypes (3 majors, 7 minors and 1 queen) were examined, of which one major is designated as the **lectotype**.

Specimens examined BORNEO. Sabah, Malaysia: Poring, 900 m alt., 2 majors and 4 minors (09Q20B4), TK; Tawau Hills Park, 1 minor (Hand collecting sample: HC-3), SKY, 1996.

Major Measurements and indices (n=2): TL 1.9 mm, HL 0.93-0.98 mm, HW 0.84-0.86 mm, SL 0.40-0.41 mm, FL 0.48-0.49 mm, CI 88-90, SI 46-49, FI 57. Head in full-face view with almost parallel sides; posterior margin of head in full-face view emarginate triangularly (Fig. 15A); head in profile weakly impressed on vertex (Fig. 15B). Hypostoma bearing three median processes of which lateral two are well developed (Fig. 15C). Clypeus without a median longitudinal carina, with anterior margin of clypeus almost straight; lateral portion of clypeus produced into a low, blunt horn. Eye situated at about 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye 1.7-1.8 times as long as maximal diameter of eye. Frontal carina horizontal, extending backward to 2/3-7/10 distance of head. Antennal scrobe overhung by frontal carina. Frontal lobe exceptionally developed, suberect (Fig. 15A, B). Antenna with 3-segmented club; scape extending backward to about midlength of head; terminal segment ca. 1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and two indistinct denticles in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity (Fig. 15E); each dorsolateral portion of the dome produced outward (Fig. 15D). Mesopleuron with an inconspicuous transverse impression.

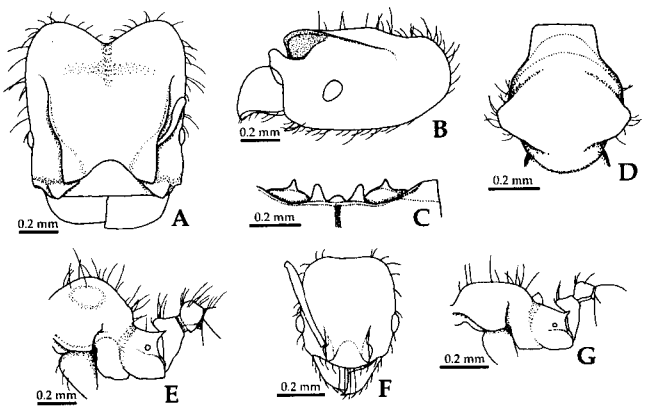

Fig. 15. ***Pheidole fantasia*** **Chapman (09Q20B4): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, promesonotum in dorsal view; E, same, alitrunk and waist in profile; F, minor, head in full-face view; G, same, alitrunk and waist in profile.**

Propodeal spine horn-like, 2.5-3 times as long as diameter of propodeal spiracle. Petiole 1.7-1.8 times as long as postpetiole (excluding helcium); petiolar node high, in posterior view slightly emarginate at apex. Postpetiole ca. 1.3 times as broad as petiolar node, in profile angulate anteroventrally.

Anterior part of frons between frontal lobes weakly punctured and dull; posterior part of frons, vertex and dorsal and lateral faces of occipital lobe reticulate, with enclosures punctured and dull; lateral face of head largely punctured and dull; dorsum of promesonotal dome reticulate with enclosures weakly punctured and weakly shining; lower part of mesopleuron partly smooth and shining; remainder of alitrunk punctured and dull; lateral faces of petiole and postpetiole punctured; dorsa of petiole and postpetiole smooth and shining; gaster smooth and shining, but punctured around the articulation with postpetiole. Outer face of mandible sparsely covered with very short appressed hairs (< 0.02 mm in length), which are much shorter than distance between piligerous punctures. Body dark reddish-brown; antennae lighter than body; legs reddish-brown, but ivory-white from apical part of femur to apex of tarsus.

Minor Measurements and indices (n=5): TL 1.2-1.3 mm, HL 0.43-0.47 mm, HW 0.39-0.42 mm, SL 0.35-0.37 mm, AL 0.53-0.55 mm, FL 0.34-0.37 mm, CI 86-92, SI 86-89, FI 85-91. Head in full-face view slightly concave posteriorly (Fig. 15F); occipital carina evanescent dorsally on head. Clypeus without a distinct median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye ca. 0.8 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape slightly extending beyond posterior border of head; terminal segment 1.2-1.3 times as long as preceding two segments together. Promesonotum in profile low, flat dorsally, without a prominence on its posterior declivity (Fig. 15G). Mesopleuron without a transverse impression. Propodeal spine, ca. 2.5 times as long as diameter of propodeal spiracle. Petiole 1.7-1.9 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole

1.3-1.4 times as broad as petiolar node.

Clypeus irregularly rugose, with punctured and dull enclosures; remainder of head, and alitrunk and lateral face of petiole punctured and dull; dorsum of petiole, and postpetiole and gaster smooth and shining. Body dark reddish-brown; antennae light brown; legs only a little lighter than alitrunk, but ivory-white from apical part of femur to apex of tarsus.

Variation The type material of *P. fantasia* is very similar to the specimens from Borneo, but the following differences are noticed: in the type material promesonotum of the minor with a pair of very low tubercles dorsolaterally; propodeal spines of the major much longer; petiolar node, postpetiole and gaster of the minor also ivory-white; anterior part of frons (between frontal lobes) of the major rugose, with punctured interspaces; head of the major shorter (CI 94-96). However, I tentatively treat the Bornean population as *P. fantasia* until additional specimens from various localities become available.

Recognition This species is easily recognised among Bornean *Pheidole* in its peculiar shape of head of the major (Fig. 15A, B), and ivory-white tibiae and tarsi in both the subcastes. The only difference between this and the closest undescribed relative, *P.* sp. eg-90 (Padang, W. Sumatra, FI97-451), is unicolored legs in the latter.

Distribution Negros and Borneo.

Bionomics This species seems to inhabit well-developed lowland forests.

15. *Pheidole fervens* Fr. Smith (Fig. 16)

Pheidole fervens Fr. Smith, 1858b: 176, major and minor (BMNH). Type locality: Singapore. Three syntypes (1 major and 2 minors) were examined.

Pheidole javana Mayr, 1867: 98, major and minor. Type locality: Java. Junior synonym of *P. fervens*: Wilson & Taylor, 1967: 45. Type material not examined by me.

Pheidole javana var. *desucta* Wheeler, 1929a: 2, major, minor and queen (MCZ, cotype-20659). Type locality: Back Liang, China. Subspecies of *P. fervens*: Bolton, 1995b. Seven syntypes (2 majors, 2 minors and 3 queens) were examined of which one major was designated as the **lectotype. New synonymy**.

Pheidole (*Pheidole*) *oceanica* var. *nigriscapa* Santschi, 1928: 48, major and minor. Type locality: SAMOA. Junior synonym of *P. fervens*: Wilson & Taylor, 1967: 45. Type material not examined by me.

Pheidole oceanica subsp. *nigriscapa* var. *tahitiana* Santschi, in Cheesman & Crawley, 1928: 516, minor. Type locality: Tahiti. Unavailable name, material referred to *P. fervens*: Wilson & Taylor, 1967: 45. Type material not examined by me.

Subspecies enumerated in Bolton, 1995b: nominal plus *desucta*, see above; *dharmsalana* Forel, 1902: 184, 198, India; *dolenda* Forel, 1912a: 60, Taiwan; *jacobsoni* Forel, 1911b: 203, Java; *jubilans*, 1911b: 202, Java; *pectinata* Stitz, 1912: 504, Seram I. (Indonesia); *protea* Forel, 1912d: 55, Sumatra; *soror* Santschi, 1937b: 369, Taiwan (for these forms excluding *desucta* type material was not examined by me).

Specimens examined BORNEO. Sabah, Malaysia: Tawau Hills Park, 9 majors and 20 minors (Eg96-BOR-009, 021). Sarawak, Malaysia: Niah N. P., 1 major and 6 minors (GC), SKY, 1993. E. Kalimantan, Indonesia: Kutai N. P., 1 minor (GC), E. Suzuki leg., 1986. NANSEI IS., Japan. Iriomote-jima I., Yaeyama Is., 3 majors, 3 minors and 1 queen (Colony: 96-JPN-001, 003), KE, 1996. MYEIK'S ARCHIPELAGO, Myanmar. Cat & Kitten I., 4 majors and 16 minors, Ecoswiss coll., 1999 (MZLS). PALAWAN, Philippines. Pupok, Napsan, 18 minors (GC), H. Fukuda leg., 1995. SUMATRA, Indonesia. Maninjau, W. Sumatra, 15 majors and 20 minors, SNS; Sako, nr. Tapan, W. Sumatra, 3 majors and 9 minors, SNS; Sukarami, nr. Padang, W. Sumatra, 2 majors and 5 minors (9/28a), MK, 1999; Ulu Gadut, nr. Padang, W. Sumatra, 2 minors, SNS. MENTAWAI IS., Indonesia. Pulau Sipora, 5 minors, SNS. JAVA, Indonesia: Kebun Raya, Bogor, 1 major and 2 minors (153), MK, 1998.

Major Measurements and indices (n=5): TL 2.8-3.4 mm, HL 1.26-1.37 mm, HW 1.23-1.32 mm,

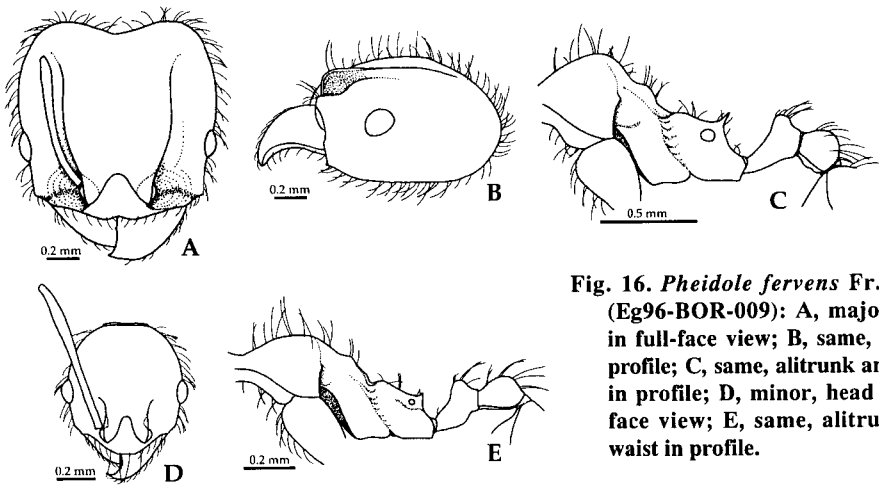

Fig. 16. *Pheidole fervens* Fr. Smith (Eg96-BOR-009): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

SL 0.82-0.86 mm, FL 1.10-1.17 mm, CI 96-98, SI 65-69, FI 88-91. Head broadest at 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head in full-face view weakly concave (Fig. 16A); head in profile not impressed on vertex (Fig. 16B). Hypostoma with three indistinct median processes. Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.3-1.4 times as long as maximal diameter of eye. Frontal carina distinct, extending backward to 3/4-4/5 distance of head. Antennal scrobe inconspicuous, running along frontal carina. Antenna with 3-segmented club; scape extending backward to about 3/4 distance of head; terminal segment ca. 0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a low prominence on its posterior declivity (Fig. 16C); the prominence in anterior view not concave medially. Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, straight or slightly curved, 2-2.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.3-1.5 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, ca. 1.8 times as broad as petiolar node.

Frons to vertex longitudinally rugose, with interspaces very weakly punctured and weakly shining; dorsal and lateral faces of occipital lobe rugoso-reticulate, with enclosures weakly punctured and weakly shining; antennal scrobe punctured; area between antennal scrobe and subocular level largely reticulate, with enclosures punctured and dull; promesonotum smooth and shining with several short rugulae; mesopleuron and lateral face of propodeum punctured; petiole (excluding smooth and shining anterodorsal face) and lateral face of postpetiole slightly punctured; dorsum of postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with short appressed hairs, which are 0.04-0.06 mm in length and a little shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of appressed to decumbent hairs. Body brown with darker gaster.

Minor Measurements and indices (n=6): TL 2.0-2.2 mm, HL 0.66-0.73 mm, HW 0.57-0.63 mm, SL 0.78-0.85 mm, AL 0.92-1.02 mm, FL 0.83-0.93 mm, CI 82-87, SI 134-141, FI 145-154. Head in full-face view oval (Fig. 16D), with conspicuous occipital carina. Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate medially. Eyes situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.8-0.9 times as long as preceding two segments together. Promesonotal dome with a very low prominence on its posterior declivity (Fig. 16E). Mesopleuron without a transverse impression. Propodeal spine elongate-triangular, ca. 1.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.3-1.4 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, 1.6-1.7 times as broad as petiolar node.

Head including clypeus smooth and shining, with several rugulae between antennal insertion and eye; promesonotum smooth and shining; mesopleuron and lateral face of propodeum punctured; lateral face of petiole slightly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body light brown with darker head and gaster; flagella and legs a little lighter than alitrunk.

Recognition This medium-sized species with general habitus is recognised among morphologically similar Bornean congeners by the characters given in the key.

Distribution Widespread throughout subtropical and tropical Asia, from China to the Moluccas, and spottily distributed in the Pacific Region where it has apparently been spread by human commerce (Wilson & Taylor, 1967).

Bionomics This species inhabits open lands and forest edges, and nests in the soil and under stones.

16. *Pheidole ghigii* Emery (Fig. 17)

Pheidole ghigii Emery, 1900: 685, major and minor (MCSN). Type locality: Sumatra. Redescription of type material: Eguchi, 2001.

Specimens examined BORNEO. Sarawak, Malaysia: Bako N. P., 1 major and 18 minors (GC), SKY, 1993; Old Tower Region, Lambir Hills N. P., 1 major and 9 minors (GC), SKY, 1993 / 50 ha plot, 1 major and 6 minors (GC), SKY, 1993.

Major Measurements and indices (n=3): TL 2.4-3.1 mm, HL 1.30-1.47 mm, HW 1.22-1.39 mm, SL 0.60-0.65 mm, FL 0.82-0.88 mm, CI 94-95, SI 47-49, FI 63-67. Head broadest around 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 17A), in profile not impressed on vertex (Fig. 17B). Hypostoma bearing a pair of large median processes (Fig. 17C). Clypeus without a median longitudinal carina, with anterior margin weakly concave medially. Eye situated just in front of 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.9-2.2 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to 3/5 distance of head. Antennal scrobe only present around antennal insertion. Antenna with 3-segmented club; scape extending backward to 1/2-3/5 distance of head; terminal segment ca. 1.1 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotum forming a high dome, with a distinct prominence on

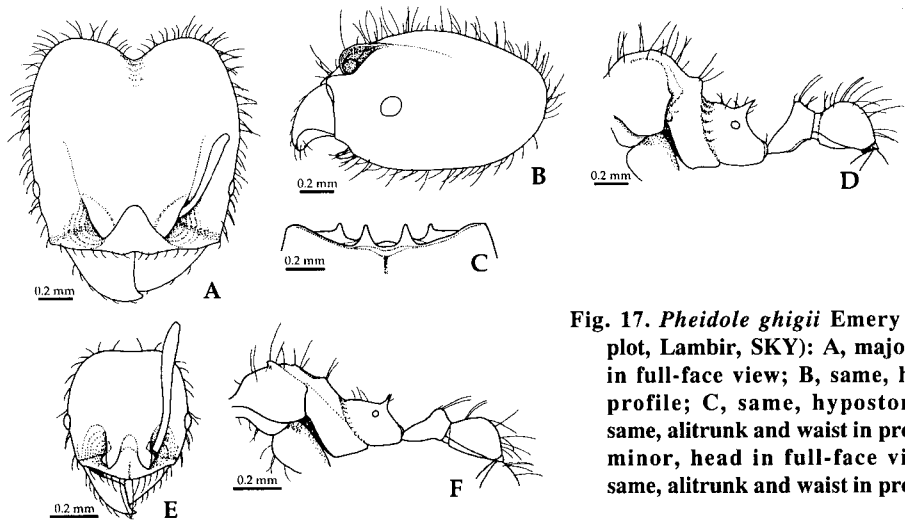

Fig. 17. *Pheidole ghigii* Emery (50 ha plot, Lambir, SKY): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.

its posterior declivity (Fig. 17D); the prominence in anterior view not or very weakly concave medially; each dorsolateral portion of the dome weakly produced outward. Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, 2.5-3 times as long as diameter of propodeal spiracle. Petiole almost as long as postpetiole (excluding helcium); petiolar node in posterior view distinctly emarginate at apex. Postpetiole 2.2-2.4 times as broad as petiolar node.

Frons longitudinally rugose; vertex, and dorsal and lateral faces of occipital lobe reticulate; dorsum of promesonotum irregularly rugose, with smooth and shining enclosures; dorsal and declivitous faces of propodeum weakly punctured; remainder of alitrunk weakly rugoso-reticulate, with weakly punctured enclosures; petiole (excluding its smooth and shining anterior face) and postpetiole weakly punctured and dull; gaster largely smooth and shining. Outer face of mandible sparsely covered with appressed hairs, which are 0.04-0.06 mm in length and shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with appressed to decumbent hairs. Body yellowish-brown with darker mandibles and clypeus.

Minor Measurements and indices (n=6): TL 1.6-1.7 mm, HL 0.58-0.60 mm, HW 0.53-0.55 mm, SL 0.55-0.59 mm, AL 0.75-0.80 mm, FL 0.59-0.62 mm, CI 90-93, SI 105-109, FI 110-114. Head in full-face view slightly concave posteriorly (Fig. 17E); occipital carina evanescent dorsally on head. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 1.3-1.5 times as long as maximal diameter of eye. Clypeus with a weak median longitudinal carina, with anterior margin in full-face view slightly convex medially. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by its 1/5 length; terminal segment ca. 1.1 times as long as preceding two segments together. Promesonotum forming a high dome, with a pair of low tubercles dorsolaterally, with a low but distinct prominence on its posterior declivity (Fig. 17F). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, 2-2.5 times as long as diameter of propodeal spiracle. Petiole 0.9-1.0 times as long as postpetiole (excluding helcium) (Fig. 17F); petiolar node in posterior view not emarginate at apex. Postpetiole massive, in dorsal view subhexagonal, 2.3-2.5 times as broad as petiolar node.

Dorsal and lateral faces of head including clypeus smooth and shining; posterolateral face of head very weakly punctured; promesonotum smooth and shining with irregular rugulae dorsally, and weakly punctured laterally and anterodorsally; remainder of alitrunk punctured; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body light yellowish-brown to yellowish-brown, with a little darker mandibles (sometimes gaster also darker than head and alitrunk).

Recognition This species is characterised among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: hypostoma of the major bearing a pair of large median processes (Fig. 17C); posterior declivity of promesonotal dome of both the subcastes bearing a distinct prominence; promesonotal dome of the minor with a pair of low tubercles dorsolaterally (Fig. 17F); eye of both the subcastes relatively small; distance between mandibular insertion and anterior margin of eye 2.0-2.1 times as long as maximal diameter of eye in the major, and 1.3-1.5 times in the minor; postpetiole in both the subcastes massive.

Distribution Borneo and Sumatra.

Bionomics Within Borneo this species has so far been collected only from well-developed lowland forests in Sarawak.

17. *Pheidole gombakensis* sp. nov. (Fig. 18)

Holotype Major, colony: FI99-134, Ulu Gombak, W. Malaysia (Southern Malay Peninsula), F. Ito leg., 1999, deposited in FRIM.

Paratype One minor from the same colony to which the holotype belongs, deposited in FRIM.

Other specimens examined BORNEO. Sabah, Malaysia: Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Poring, 560 m alt. (East Ridge), 1 minor (code AW-2), CB, 1995.

The following description and measurements are based on the holotype and paratype.

Major Measurements and indices (n=1): TL 2.2 mm, HL 0.91 mm, HW 0.78 mm, SL 0.39 mm, FL 0.49 mm, CI 86, SI 50, FI 63. Head broadest around its midlength; posterior margin of head in full-face view emarginate triangularly (Fig. 18A); head in profile not impressed on vertex (Fig. 18B). Hypostoma bearing a pair of large and stout median processes (Fig. 18C). Clypeus without a median longitudinal carina. Eye situated just in front of 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye ca. 1.5 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to 1/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about midlength of head; terminal segment ca. 1.3 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity (Fig. 18D). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, with narrow base, ca. 2.5 times as long as diameter of propodeal spiracle. Petiole nearly twice as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole ca. 1.4 times as broad as petiolar node, angulate laterally.

Frons and gena longitudinally rugose; vertex, and dorsal and dorsolateral faces of occipital lobe reticulate; dorsum of promesonotum irregularly rugose, with smooth and shining enclosures; lateral

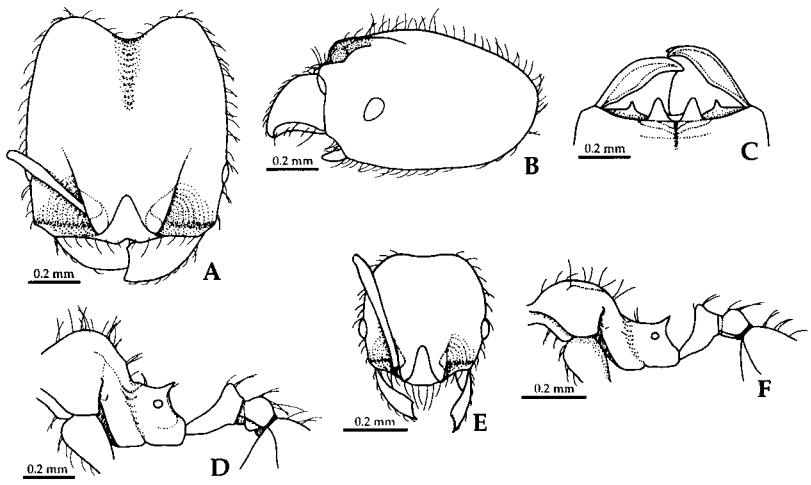

Fig. 18. ***Pheidole gombakensis*** **sp. nov. (type material: FI99-134): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.**

face of promesonotum smooth and shining; mesopleuron and lateral face of propodeum weakly punctured and weakly shining; lateral faces of petiolar pedicel and postpetiole weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible covered with decumbent hairs, which are 0.06-0.08 mm in length and longer than distance between piligerous punctures. Body brown with lighter gaster; flagella yellowish-brown; legs slightly lighter than alitrunk.

Minor Measurements and indices (n=1): TL 1.3 mm, HL 0.42 mm, HW 0.38 mm, SL 0.36 mm, AL 0.53 mm, FL 0.38 mm, CI 90, SI 95, FI 100. Head in full-face view slightly concave posteriorly (Fig. 18E); occipital carina evanescent dorsally on head. Clypeus with an evanescent median longitudinal carina, with anterior margin in full-face view truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye ca. 0.8 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape slightly extending beyond posterior border of head; terminal segment ca. 1.3 times as long as preceding two segments together. Promesonotum forming a dome which is weakly margined dorsolaterally, its posterior declivity almost lacking a prominence (Fig. 18F). Mesopleuron without a transverse impression. Propodeal spine triangular, almost twice as long as diameter of propodeal spiracle. Petiole nearly twice as long as postpetiole (excluding helcium) (Fig. 18F); petiolar node high, in posterior view not emarginate at apex. Postpetiole ca. 1.3 times as broad as petiolar node.

Clypeus and anterior part of frons smooth and shining; remainder of dorsum of head above subocular level reticulate, with smooth and shining enclosures; ventral face of head below subocular level smooth and shining; promesonotum smooth and shining; remainder of alitrunk punctured and dull; lateral face of petiolar pedicel very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body yellowish-brown.

Variation Only single minor has been collected from Borneo, which well agrees with the paratype minor except body a little darker than that of the latter.

Recognition This species, together with the closest relative *P. poringensis* sp. nov., is similar to *P. rabo* Forel and *P. tsailuni* Wheeler among Indo-Chinese and Indo-Malay congeners, and is distinguished from *P. poringensis* sp. nov. by the characteristics noted under *P. poringensis* sp. nov.

Distribution Southern Malay Peninsula and Borneo.

18. *Pheidole havilandi* Forel (Fig. 19)

Pheidole havilandi Forel, 1911a: 38, major, minor, queen and male (MHNG). Type locality: Sarawak, Borneo. Nine syntypes (2 majors, 3 minors, 1 queen and 3 males) were examined.

Pheidole havilandi var. *sapuana* Forel, 1911c: 373, major and minor (MHNG). Type locality: Sumatra. Lectotype designation and solution of synonymy (junior synonym of *P. havilandi*): Eguchi, 2001.

Pheidole havilandi var. *selangorensis* Forel, 1913: 31, major, minor, queen and male (MHNG). Type locality: Selangor, Malacca, Southern Malay Peninsula. Lectotype designation and solution of synonymy (junior synonym of *P. havilandi*): Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia: nr. Kg. Yoshina, Ranau, 2 majors and 6 minors (Eg98-BOR-849); Mahua Waterfall area, 1 minor (GC), HO, 2000; Sayap Kinabalu, 5 majors, 3 minors and 1 queen (SB96-SKY-46). Sarawak, Malaysia: Kubah N. P., 1 major and 1 minor (GC), SKY, 1993. MALAY PENINSULA. Malaysia: Ulu Gombak, 10 majors, 14 minors and 1 male (FI92MG-273, 274, 277, 416; FI98-196). SUMATRA, Indonesia: Ulu Gadut, nr. Padang, W. Sumatra, 11 majors, 22 minors and 2 queens (FI96-109, 115, 122, 193; FI97-457, 468, 470) / 6 majors and 47 minors, SNS; Limau Manis, W. Sumatra, 1 major and 2 minors (FI96-82); Lubuk Gadang, W. Sumatra, 6 majors and 21 minors, SNS; Maninjau, W. Sumatra, 1 major and 23 minors, SNS; Padang, W. Sumatra, 2 majors, 3 minors and 1 male (FI92-4); Bt. Sabalah, W. Sumatra, 2 majors, 3 minors and 3 males (FI92-235); Sako, nr. Tapan, W. Sumatra, 3 majors and 6 minors, SNS; Sukarami, nr. Padang, W. Sumatra, 7 majors and 11 minors (FI92-63, 84; FI96-152, 154, 174). MENTAWAI IS., Indonesia. Pulau Sipora, 1 major and 2 minors, SNS.

Major Measurements and indices (n=6): TL 3.5-4.7 mm, HL 1.44-1.97 mm, HW 1.45-1.93 mm, SL 0.83-0.91 mm, FL 1.20-1.50 mm, CI 97-101, SI 47-59, FI 78-84. Head broadest around 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head gently concave medially (Fig. 19A); head in profile distinctly convex on upper frons, and without any impression on the posterior declivity from the top. Hypostoma without median processes. Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 2/5 distance of head; distance between mandibular insertion and anterior margin of eye 2.3-2.4 times as long as maximal diameter of eye (Fig. 19B). Frontal carina inconspicuous, extending backward to 3/5-2/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about 3/5 distance of head; terminal segment 1.0-1.1 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, lacking a distinct denticle in front of basal angle. Promesonotal dome without a distinct prominence on its posterior declivity (Fig. 19C). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, ca. 1.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.0-1.1 times as long as postpetiole (excluding helcium); petiolar node in posterior view slightly emarginate at apex. Postpetiole in dorsal view subpentagonal, 2.2-2.3 times as broad as petiolar node.

Frons and gena longitudinally rugose; vertex and occipital lobe smooth and shining; alitrunk largely smooth and shining, or upper part of mesopleuron and anterolateral part of propodeum weakly punctured; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole largely smooth and shining; gaster smooth and shining. Outer face of mandible sparsely covered with long appressed to decumbent hairs, which are 0.09-0.20 mm in length and almost as long as distance between

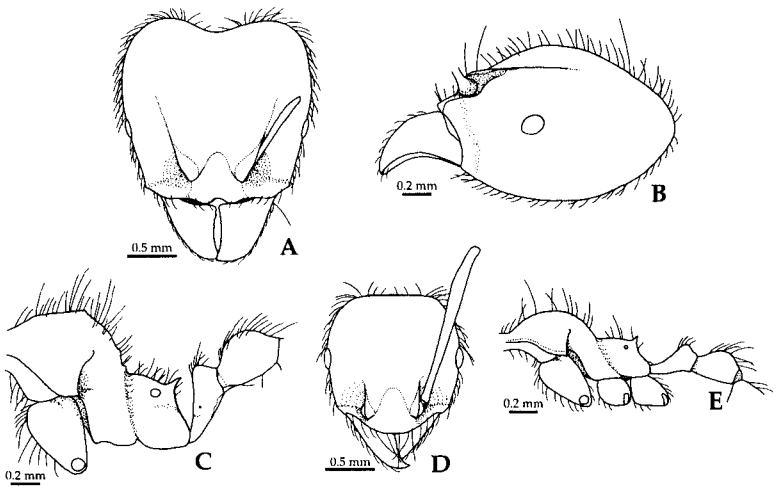

Fig. 19. ***Pheidole havilandi*** **Forel (Eg98-BOR-849): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

piligerous punctures. Head yellowish-brown to reddish-brown, with darker mandibles and with lighter occipital lobes; alitrunk and gaster deep yellowish-brown to brown, a little darker than head; legs a little lighter than alitrunk.

Minor Measurements and indices (n=7): TL 2.5-2.9 mm, HL 0.70-0.86 mm, HW 0.63-0.82 mm, SL 0.79-0.97 mm, AL 0.98-1.22 mm, FL 0.97-1.14 mm, CI 90-97, SI 116-125, FI 139-143. Head in full-face view with almost straight posterior margin (Fig. 19D); occipital carina weak but complete. Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate medially. Eyes situated just behind midlength of head; distance between mandibular insertion and anterior margin of eye 1.5-1.6 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.9-1.0 times as long as preceding two segments together. Promesonotal dome without a prominence on its posterior declivity (Fig. 19E). Mesopleuron sometimes with an inconspicuous transverse impression. Propodeal spine elongate-triangular, 1.5-2 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.0-1.1 times as long as postpetiole (excluding helcium); petiolar node very low, in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, 2.0-2.3 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; mesopleuron and a part of lateral face of propodeum weakly punctured; remainder of propodeum smooth and shining; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body light yellowish-brown to yellowish-brown; flagella and legs a little lighter than alitrunk.

Recognition This relatively large-sized species is characterised among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: vertex and occipital lobe smooth and shining in the major; eye relatively small in both the subcastes (Fig. 19B); hypostoma of the major lacking median processes; posterior declivity of promesonotal dome lacking a prominence

in both the subcastes (Fig. 19C, E); petiole almost as long as postpetiole in both the subcastes (Fig. 19C, E).

Distribution Southern Malay Peninsula, Borneo, Sumatra and Mentawai Is.

Bionomics This species inhabits well-developed forests from lowlands to hill areas, probably not exceeding 1000 m alt.

Together with many workers of this species (Eg98-BOR-849), many adults, nymphs and egg-masses of *Neuroctenus* sp. (Heteroptera, Aradidae, Mezirinae; determined by Dr. Yoshinori Shono, 1998) were collected from spaces under barks of buttress roots of a tree stub and shelters which were made of soil and wood particles on the roots. The bugs are very probably a myrmecophile of *P. havilandi*, and antagonistic behavior of the ants to the bugs was not observed even when I strongly disturbed the colony. Usinger & Matsuda (1959), and Kormilev (1971) stated that many aradids are mycophagous, and feed on fungi under the bark of decaying trees or in the litter. The bugs possibly have a similar diet judging from the nesting habit of *P. havilandi*. Thus in this case it is not likely for the trophobiotic interaction through excreting drops of honeydew to occur between the bugs and ants. There is a possibility that the ants maintain the bugs as prey during severe food shortage as seen in the relationship between *Myrmecina* sp. and a myrmecophilous oribatid mite (Ito, 1994).

19. *Pheidole hortensis* Forel (Fig. 20)

Pheidole hortensis Forel, 1913: 31, major, minor, queen and male (MHNG). Type locality: Java. Nine syntypes (2 majors, 3 minors, 1 queen and 3 males) were examined.

Specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 3 majors and 5 minors (Eg96-BOR-116); Gunong Rara, 14 majors and 21 minors (Eg96-BOR-316, 355, 365, 366); Kinabalu Park Headquarters area, 6 majors, 10 minors and 1 queen (Eg97-BOR-378, 379) / ca. 1500 m alt., 1 major, 2 minors and 1 male (15Q13B5), TK; nr. Kota Kinabalu, 12 majors, 18 minors, 1 queen and 2 males (Eg96-BOR-070, 095, 105, 106); Poring, 450-500 m alt., 4 majors, 7 minors and 16 males (Eg96-BOR-283) / 500-550 m alt., 1 major, 4 minors and 1 male (Eg96-BOR-305) / ca. 600 m alt., 36 majors, 49 minors, 1 queen and 2 males (734, 735A; 06Q31B5, 06Q32B3, 06Q32S5, 06Q36B5, 06Q42B5, 06Q45S5, 06Q52S6, 6X106-13-Da, 6X3006-11-Ae, 6X3006-11-Ca, 6X3006-11-Eb, 6X3006-12-2, 6X3006-12-6, 6XI0106-14-Ca, 6XI0106-14-Da, 6XI0106-14-Fb, 6XI016-14-Ba, 6XI1006-17-Ea, 6XI1006-18-1, 6XII2306-27-Ad, 6XII2306-27-Ae, 6XII2306-Aa), TK / ca. 900 m alt., 8 majors and 15 minors (B9; 09Q14B4, 09Q26S3; 7IV0210-4-Ad, 7IV05-7-2a, 7IV0510-7-Cb), TK; Sayap Kinabalu, 15 majors, 19 minors and 1 male (Eg96-BOR-045, 050, 062, 063) / 1 major (GC), SKY, 1996; Sepilok forest, 36 majors, 57 minors, 3 queens and 16 males (Eg97-BOR-438, 443, 444, 448, 461, 469, 470, 488, 494; Eg98-BOR-860, 862, 883); Tawau Hills Park, 8 majors, 8 minors, 2 queens and 1 male (Eg96-BOR-011, 036). Brunei: Belalong Forest Section, 2 majors and 2 minors (Eg99-BOR-233); Merimbun Heritage Park, 12 majors, 12 minors, 1 queen and 10 males (Eg99-BOR-514, 574, 578, 601, 604). MALAY PENINSULA. Malaysia: Ulu Gombak, 3 majors and 6 minors (FI96-548, FI98-172). SUMATRA, Indonesia. Sitiung, W. Sumatra, 1 major and 2 minors (FI93-256); Sukarami, nr. Padang, W. Sumatra, 2 majors, 4 minors and 1 queen (FI96-165). JAVA, Indonesia. Mt. Halimun, 2 majors and 3 minors (5-6e), MK, 1998; Kebun Raya, Bogor, 8 majors, 13 minors, 5 queens and 2 males (FI95-353, 381, 392, 398, 471, 472, 573, 751, 775) / 7 majors and 14 minors (44, 10/5a, 10/8a, 10/8e), MK, 1997 and 1999; Ujung Kulon, W. Java, 2 majors (FI97-169).

Major Measurements and indices (n=9): TL 1.8-2.6 mm, HL 0.87-1.15 mm, HW 0.77-1.05 mm, SL 0.38-0.48 mm, FL 0.46-0.62 mm, CI 85-95, SI 45-53, FI 55-63. Head broadest at about 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 20A), in profile weakly impressed on vertex (Fig. 20B). Hypostoma bearing a median process, which is sometimes much reduced compared with the process just mesal to each mandibular insertion (arrows in Fig. 20C). Clypeus without a

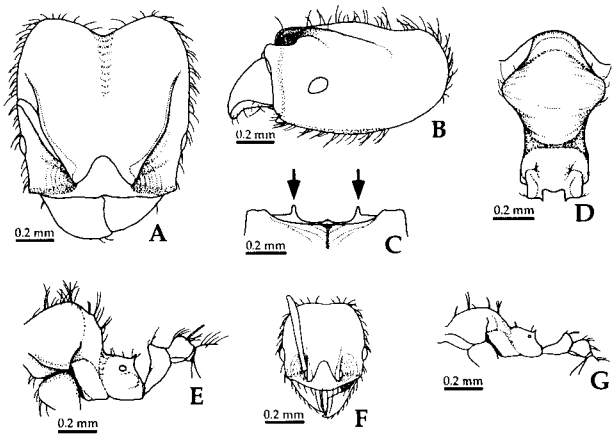

Fig. 20. ***Pheidole hortensis*** **Forel (Eg98-BOR-883): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk in dorsal view; E, same, alitrunk and waist in profile; F, minor, head in full-face view; G, same, alitrunk and waist in profile.**

median longitudinal carina, with anterior margin very weakly concave medially; each lateral part of clypeus weakly produced dorsally, but not well developed into a horn as seen in *P. clypeocornis* sp. nov. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.8 times as long as maximal diameter of eye. Frontal carina horizontal, extending backward to about 3/5-2/3 distance of head (Fig. 20A). Antennal scrobe narrowly overhung by frontal carina. Antenna with 3-segmented club; antennal scape extending backward to 1/2-3/5 distance of head; terminal segment 1.1-1.3 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and two denticles in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity (Fig. 20E); each dorsolateral portion of the dome roundly and strongly produced outward (Fig. 20D). Mesopleuron divided by a weak transverse impression into upper and lower parts. Propodeal spine triangular or elongate-triangular, 1.5-2 times as long as diameter of propodeal spiracle. Petiole 1.6-1.8 times as long as postpetiole (excluding helcium); petiolar node in posterior view not, or slightly, emarginate at apex. Postpetiole 1.5-1.8 times as broad as petiolar node.

Dorsum of head excluding occipital lobe longitudinally rugose, with interspaces smooth and shining (rarely punctured very weakly); dorsal and dorsolateral faces of occipital lobe reticulate, with enclosures smooth and shining (rarely punctured very weakly); outer face of mandible rugose only laterally near its base; dorsum of promesonotal dome smooth and shining with several transverse rugulae; upper part of mesopleuron weakly punctured; lower part of mesopleuron smooth and shining; propodeum smooth and shining, or weakly punctured in part; ventral faces of midcoxa and hindcoxa distinctly reticulate over the surface; lateral face of petiole slightly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Outer face of mandible sparsely covered with very short appressed hairs (< 0.03 mm in length), which are (much) shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer appressed hairs. Body yellowish-brown, reddish-brown or brown, with darker mandibles, clypeus and gaster

(sometimes promesonotum also darker), or blackish-brown with lighter mandibles, waist and gaster; legs a little lighter than alitrunk.

Minor Measurements and indices (n=9): TL 1.3-1.7 mm, HL 0.41-0.50 mm, HW 0.39-0.48 mm, SL 0.35-0.47 mm, AL 0.52-0.65 mm, FL 0.36-0.48 mm, CI 93-97, SI 91-103, FI 92-101. Head in full-face view almost flat posteriorly (Fig. 20F); occipital carina almost absent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.7-0.8 times as long as maximal diameter of eye. Frontal carina rarely present as an evanescent rugula extending beyond midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 1/5 length; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotal dome without any prominence on its posterior declivity (Fig. 20G). Mesopleuron sometimes with an inconspicuous transverse impression. Propodeal spine ca. 1.5 times as long as diameter of propodeal spiracle. Petiole 1.5-1.6 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole ca. 1.7 times as broad as petiolar node.

Clypeus smooth and shining; remainder of head largely smooth and shining, or weakly rugoso-reticulate between eye and antennal insertion; promesonotum smooth and shining; remainder of alitrunk punctured at least partly; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body light yellowish-brown, yellowish-brown or light brown, sometimes with a little darker head and gaster.

Recognition *P. hortensis* is closely related to *P. maculifrons* Wheeler, *P. tenebricosa* sp. nov., *P. clypeocornis* sp. nov., *P. kikutai* sp. nov. and *P. rugifera* sp. nov. All these are well recognisable among Indo-Chinese and Indo-Malayan congeners in having the following exceptional characteristics: masticatory margin of mandible bearing two denticles just in front of basal angle in the major (this condition is seen in only *P. fantasia* Chapman except the above six species); ventral faces of midcoxa and hindcoxa distinctly reticulate (this condition is seen in only *P. aristotelis* except the above six species). The following characteristics are also shared among the six species: frontal carina of the major horizontal, and (narrowly) overhanging antennal scrobe (Fig. 20A); hypostoma of the major bearing a median process. *P. maculifrons* Wheeler (1929b: 42) is easily distinguished from the other five species collected from Borneo by having frons very weakly rugose longitudinally, vertex almost smooth and shining, dorsum of occipital lobe weakly reticulate, and alitrunk smooth and shining (one syntype major of *P. maculifrons*, labelled as "Holotype, MCZ, 22884", was examined; close relationship between *P. hortensis* and *P. maculifrons* has already been suggested in Wheeler's original description). *P. hortensis* is distinguished from remainder of the five Bornean species as follows: in *P. tenebricosa* sp. nov. head and alitrunk of the minor punctured; in *P. clypeocornis* sp. nov. each lateral part of clypeus of the major developed into a horn (Fig. 11); in *P. kikutai* sp. nov. occipital carina of the minor complete (Fig. 23D); in *P. rugifera* sp. nov. head and alitrunk of the minor punctured, and outer face of mandible of the major with rugulae which run from its base toward masticatory margin (Fig. 43A).

Distribution Southern Malay Peninsula, Borneo, Sumatra and Java.

Bionomics This species inhabits not only well-developed forests but also drier and shrubby vegetation. The species usually nests in rotting twigs and wood blocks on the ground, and stores up a number of tiny seeds in its nest (Eg96-BOR-062; Eg97-BOR-378, 448, 470). I have never encountered colonies containing more than one dealate queen.

20. *Pheidole huberi* Forel (Fig. 21)

Pheidole huberi Forel, 1911c: 374, major and minor (MHNG). Type locality: Sumatra. Lectotype designation and redescription of type material: Eguchi, 2001.

Pheidole huberi var. *perakensis* Forel, 1911c: 376 and 386, major, minor and queen (MHNG). Type locality: Perak, W. Malaysia. Revised status as subspecies of *P. huberi*: Bolton, 1995b. Lectotype designation and solution of synonymy (as a junior synonym of *P. huberi*): Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia: Tawau Hills Park, 6 majors and 14 minors (SB96-SKY-10). Sarawak, Malaysia: Bako N. P., 1 minor (GC), SKY, 1993; G. Gading N. P., 1 major and 1 minor (GC), Abd. Rahman Nona leg., 1994; Lambir Hills N. P., 5 majors and 17 minors (GC), SKY, 1993 and 1997; Mulu (lowland), 5 minors (GC), SKY, 1993; Niah N. P., 1 minor (GC), SKY, 1993. MALAY PENINSULA. Malaysia: Ulu Gombak, 2 majors and 3 minors (FI99-113).

Major Measurements and indices (n=7): TL 3.6-3.9 mm, HL 1.56-1.66 mm, HW 1.58-1.70 mm, SL 0.93-0.99 mm, FL 1.39-1.46 mm, CI 96-102, SI 54-62, FI 82-91. Head broadest at about 4/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head broadly concave medially (Fig. 21A); head in profile not impressed on vertex (Fig. 21B). Hypostoma with three median processes (medianmost one of them lower) (Fig. 21C). Clypeus with a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.7-1.9 times as long as maximal diameter of eye. Frontal carina weak, extending backward to about 2/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape reaching 2/3-3/4 distance of head; terminal segment 0.8-0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome without a distinct prominence on its posterior declivity (Fig. 21D). Mesopleuron with a weak transverse impression. Propodeal spine horn-like, 4.5-5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.4-1.5 times as long as postpetiole (excluding helcium); petiolar node in posterior view slightly emarginate at apex. Postpetiole 1.7-1.9 times as broad as petiolar node.

Frons longitudinally rugose, with smooth and shining interspaces; the longitudinal rugulae curving outward on occipital lobes (Fig. 21A); area between frontal carina and subocular level rugoso-reticulate; lateral face of head in front of eye longitudinally rugose; dorsum of promesonotum smooth and shining, sometimes with transverse rugulae; lateral face of promesonotum largely smooth and shining or with rugulae; mesopleuron and lateral face of propodeum rugoso-reticulate, with weakly punctured enclosures; dorsa of petiole and postpetiole smooth and shining, and their lateral faces weakly punctured; gaster smooth and shining. Head with few standing hairs, and scattered short appressed hairs; outer face of mandible sparsely covered with very short appressed hairs, which are 0.02-0.04 mm in length and much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer hairs; alitrunk completely lacking standing hairs, with scattered short appressed hairs. Body reddish-brown to dark reddish-brown, sometimes with a little darker occipital lobe, dorsum of alitrunk and gaster.

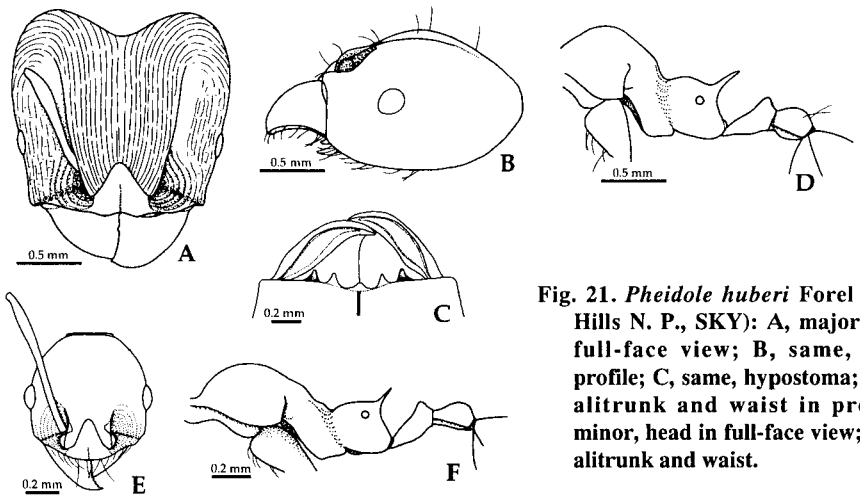

Fig. 21. ***Pheidole huberi*** **Forel (Lambir Hills N. P., SKY): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist.**

Minor Measurements and indices (n=13): TL 2.3-3.0 mm, HL 0.67-0.87 mm, HW 0.58-0.76 mm, SL 0.80-1.01 mm, AL 0.97-1.25 mm, FL 0.98-1.27 mm, CI 87-90, SI 130-140, FI 163-174. Head in full-face view oval (Fig. 21E); occipital carina distinct. Clypeus with a median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 1.0-1.1 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.8-0.9 times as long as preceding two segments together. Promesonotal dome without a distinct prominence on its posterior declivity (Fig. 21F). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, 4.5-5 times as long as diameter of propodeal spiracle. Petiole elongate-cuneiform, 1.3-1.4 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole 1.8-2.0 times as broad as petiolar node.

Clypeus very weakly rugose and weakly shining; remainder of head largely smooth and shining; area between antennal insertion and eye weakly punctured with several rugulae; promesonotum smooth and shining; mesopleuron and propodeum punctured; lateral face of petiole slightly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Head with few standing hairs (Fig. 21E), and alitrunk completely lacking them (Fig. 21F), but whole body with scattered short appressed hairs. Body reddish-brown, brown or dark brown, sometimes with a little darker head.

Recognition This medium- to large-sized species is characterised among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: alitrunk completely lacking standing hairs in both the subcastes (Fig. 21D, F); posterior declivity of promesonotal dome lacking a distinct prominence in both the subcastes (Fig. 21D, F); hypostoma of the major bearing three median processes (Fig. 21C).

Distribution Southern Malay Peninsula, Borneo and Sumatra.

Bionomics This species inhabits well-developed forests.

21. *Pheidole inornata* sp. nov. (Fig. 22)

Holotype Major, colony: Eg96-BOR-064, Sayap Kinabalu (1000 m alt.), Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1996, deposited in UMS.

Paratypes 16 majors, 18 minors and 15 males from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Sayap Kinabalu, 4 majors, 8 minors, 1 queen and 15 males (Eg96-BOR-052, 060) / 1 major, 2 minors and 1 queen (SB96-SKY-38); Tambunan Villadge Resort Centre, Tambunan, 1 major and 1 minor (MA00-HO-020). INDOCHINA. Thailand: Khao Yai N. P. (ca. 700 m alt.), Nakhonratchasima, 2 majors, 5 minors and 4 males (TH00-SKY-17)

Major Measurements and indices (n=5): TL 3.1-3.9 mm, HL 1.35-1.48 mm, HW 1.20-1.34 mm, SL 0.93-0.96 mm, FL 1.22-1.32 mm, CI 87-91, SI 71-80, FI 94-101. Head broadest at about 3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head in full-face view weakly concave (Fig. 22A); head in profile not impressed on vertex (Fig. 22B). Hypostoma with a pair of small median processes. Clypeus without a distinct median longitudinal carina, with anterior margin emarginate medially. Eye situated just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.7-2.0 times as long as maximal diameter of eye. Frontal carina distinct, extending backward to about 3/4 distance of head (Fig. 22A). Antennal scrobe weak, running along frontal carina. Antenna with 3-segmented club; scape extending backward to about 4/5-5/6 distance of head; terminal segment 0.8-0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 22C); the prominence in anterior view not concave medially. Mesopleuron with a weak or inconspicuous transverse impression. Propodeal spine horn-like, slightly curved, 2.5-3 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.3-1.4 times as long as postpetiole (excluding helcium); petiolar node low, in profile rounded and in posterior view weakly or very weakly emarginate at apex. Postpetiole in dorsal view subpentagonal, angulate laterally, 1.9-2.0 times as broad as petiolar node.

Frons and gena longitudinally rugose; dorsal and lateral faces of occipital lobe reticulate; mandible rugose from its base toward masticatory margin; promesonotal dome in dorsal view largely smooth and shining, with several transverse rugulae; mesopleuron and lateral face of propodeum irregularly and weakly rugose, with enclosures punctured weakly and dull; lateral face of petiole weakly punctured; dorsum of petiole smooth and shining; dorsum of postpetiole very weakly punctured and weakly shining; gaster smooth and shining. Outer face of mandible covered with decumbent hairs, which are 0.06-0.12 mm in length and (a little) longer than distance between piligerous punctures. Body yellowish-brown or reddish-brown, with darker mandibles (sometimes gaster also darker); legs a little lighter than alitrunk.

Minor Measurements and indices (n=5): TL 2.5-2.6 mm, HL 0.70-0.75 mm, HW 0.55-0.60 mm, SL 0.90-0.95 mm, AL 1.00-1.06 mm, FL 0.96-1.03 mm, CI 78-81, SI 153-163, FI 168-176. Head in full-face view oval (Fig. 22D); occipital carina distinct. Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate or slightly concave medially. Eye situated at about midlength of head; distance between mandibular insertion and anterior margin of eye ca. 1.1 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by more

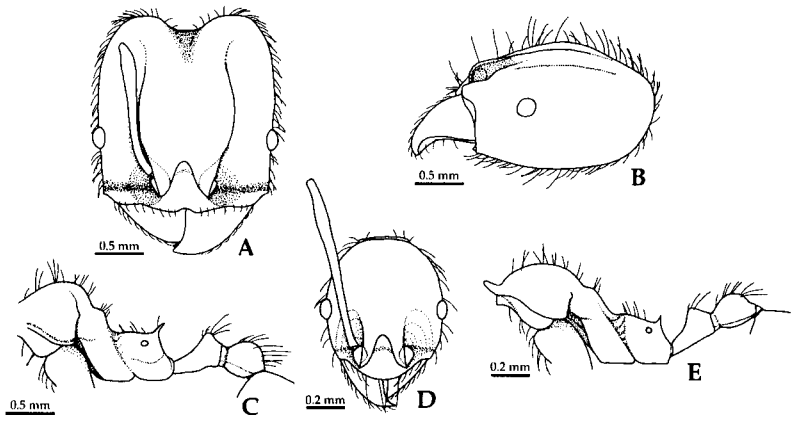

Fig. 22. ***Pheidole inornata*** **sp. nov. (type material: Eg96-BOR-064): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

than its 1/3 length; terminal segment 0.8-0.9 times as long as preceding two segments together. Promesonotal dome with a low prominence on its posterior declivity (Fig. 22E). Mesopleuron with an inconspicuous transverse impression. Propodeal spine elongate-triangular, directing upward, ca. 1.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.2-1.3 times as long as postpetiole (excluding helcium); petiolar node low, in profile rounded and in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, 1.9-2.1 times as broad as petiolar node.

Clypeus smooth and shining; large part of dorsum of head above subocular level punctured very weakly but shining, and venter of head below subocular level smooth and shining; promesonotal dome largely smooth and shining (partly very weakly punctured); mesopleuron and lateral face of propodeum weakly punctured; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body yellowish-brown; legs a little lighter than alitrunk.

Recognition This species with a general habitus is similar to *P. aglae* Forel and *P. plagiaria* Fr. Smith, but in *P. aglae* posterior margin of head of the major is more distinctly emarginate (Fig. 4A, B), and occipital carina of the minor forming a well-developed flange (Fig. 4E, F); and in *P. plagiaria* posteriormost part of occipital lobe of the major is almost transversely rugose (Fig. 34A).

Distribution Indochina and Borneo.

Bionomics This species has so far been collected from Sayap Kinabalu (ca. 1000 m alt.) and Tambunan in Sabah, and Khao Yai N. P. in Thailand. Colonies of this species and *Odontomachus rixosus* Fr. Smith (Formicidae, Ponerinae) nested together under rocks along the main trail in Sayap (*e.g.*, Eg96-BOR-060, 064), or within a rotting log near the headquarters (Khao Yai N. P.). In Thailand and Java *Pheidole tandjongensis* Forel is also a partner of *O. rixosus* (F. Ito, pers. com., 1999; Sk. Yamane, pers. com., 2000). The presence of the *Pheidole* species is, however, not indispensable for *O. rixosus*, because *O. rixosus* usually nests solely in other localities in Borneo.

22. *Pheidole kikutai* sp. nov. (Fig. 23)

Holotype Major, colony: 22B, Poring (ca. 900 m alt.), Sabah, E. Malaysia (Borneo), T. Kikuta leg., 1997,

deposited in UMS.

Paratypes 2 majors and 3 minors from the same colony to which the holotype belongs, deposited in BMNH and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Poring, ca. 900 m alt., 2 majors and 3 minors (09Q21S4), TK.

Major Measurements and indices (n=5): TL 2.5-2.6 mm, HL 1.10-1.16 mm, HW 1.07-1.13 mm, SL 0.56-0.58 mm, FL 0.68-0.73 mm, CI 94-97, SI 52-54, FI 63-68. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 23A), in profile impressed on vertex (Fig. 23B). Hypostoma bearing a median process. Clypeus without a median longitudinal carina, with anterior margin weakly concave medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.6-1.7 times as long as maximal diameter of eye. Frontal carina horizontal, extending backward to about 2/3-3/4 distance of head. Antennal scrobe narrowly overhung by frontal carina. Antenna with 3-segmented club; scape extending backward to 3/5-2/3 distance of head; terminal segment ca. 1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and two denticles in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity (Fig. 23C); each dorsolateral portion of the dome weakly produced outward. Mesopleuron divided by a weak transverse impression. Propodeal spine triangular or elongate-triangular, 2.5 times as long as diameter of propodeal spiracle. Petiole 1.4-1.5 times as long as postpetiole (excluding helcium); petiolar node in profile acute and in posterior view slightly emarginate at apex. Postpetiole 1.8-2.0 times as broad as petiolar node.

Frons longitudinally rugose, with smooth and shining interspaces; dorsal and dorsolateral faces of occipital lobe reticulate, with enclosures punctured very weakly but shining; outer face of mandible with rugulae only laterally near it base; dorsal face of promesonotal dome smooth and shining or very weakly punctured, with several transverse rugulae; a part of lateral face of promesonotum and lower part of mesopleuron smooth and shining; remainder of alitrunk punctured and dull; ventral faces of midcoxa and hindcoxa distinctly reticulate; lateral faces of petiole and postpetiole very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with appressed hairs, which are 0.02-0.03 mm in length and much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer hairs. Body yellowish-brown to brown, with darker gaster; legs lighter than alitrunk.

Minor Measurements and indices (n=6): TL 1.4-1.6 mm, HL 0.49-0.52 mm, HW 0.44-0.47 mm, SL 0.50-0.54 mm, AL 0.68-0.72 mm, FL 0.53-0.57 mm, CI 88-91, SI 112-118, FI 118-124. Head in full-face view oval; occipital carina low but complete (Fig. 23D). Clypeus occasionally with an inconspicuous median longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye ca. 0.9 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 1/4 length; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotum forming a gentle dome, with a pair of inconspicuous tubercles dorsolaterally, without any prominence on its posterior declivity (Fig. 23E). Mesopleuron

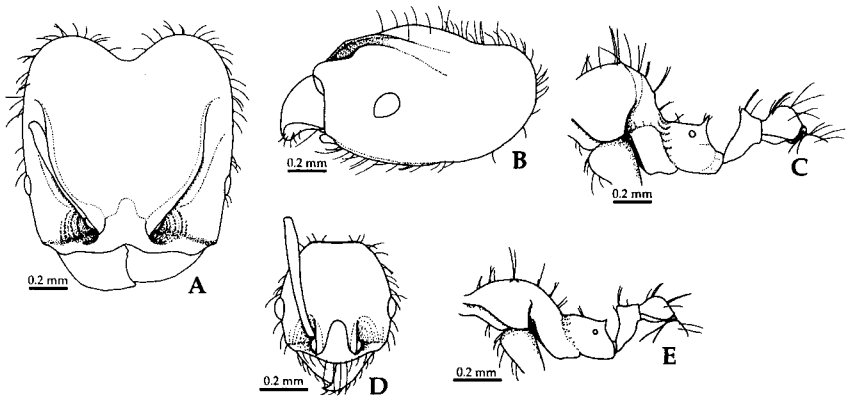

Fig. 23. ***Pheidole kikutai*** **sp. nov. (type material: 22B): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

without distinct transverse impression. Propodeal spine ca. 1.5 times as long as diameter of propodeal spiracle. Petiole ca. 1.4 times as long as postpetiole (excluding helcium). Postpetiole 1.8-2.0 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; remainder of alitrunk punctured; lateral face of petiole slightly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body yellowish-brown.

Recognition *P. kikutai* sp. nov. is closely related to *P. maculifrons* Wheeler (known only from the Philippines), *P. rugifera* sp. nov., *P. clypeocornis* sp. nov., *P. tenebricosa* sp. nov. and *P. hortensis* Forel, and all these share the characteristics noted under *P. hortensis*. *P. kikutai* sp. nov. is distinguishable from other Bornean species by its complete occipital carina of the minor (Fig. 23D).

Distribution Borneo.

23. *Pheidole lokitae* Forel (Fig. 24)

Pheidole (*Pheidolacanthinus*) *lokitae* Forel, 1913: 46, major, minor, queen and male (MHNG). Type locality: Sumatra. Nine syntypes (3 majors, 3 minors and 3 queens) were examined.

Pheidole lokitae: Bolton, 1995b: 324.

Specimens examined BORNEO. Sabah, Malaysia: Mahua Waterfall area, 6 majors and 24 minors (Eg00-BOR-102). SUMATRA, Indonesia: Sukarami, Padang, W. Sumatra, 3 majors, 18 minors and 1 male (FI92-56, 72; FI96-153, 180).

Major Measurements and indices (n=5): TL 6.0-6.3 mm, HL 2.55-2.74 mm, HW 2.79-2.91 mm, SL 1.46-1.54 mm, FL 2.15-2.21 mm, CI 106-110, SI 52-53, FI 76-79. Head broadest at about 3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head weakly concave medially (Fig. 24A); head in profile at most very weakly impressed on vertex (Fig. 24B). Hypostoma with a pair of stout median processes. Clypeus with a median longitudinal carina, with anterior margin emarginate medially. Eye situated just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 2.0-2.1 times as long as maximal diameter of eye. Frontal carina

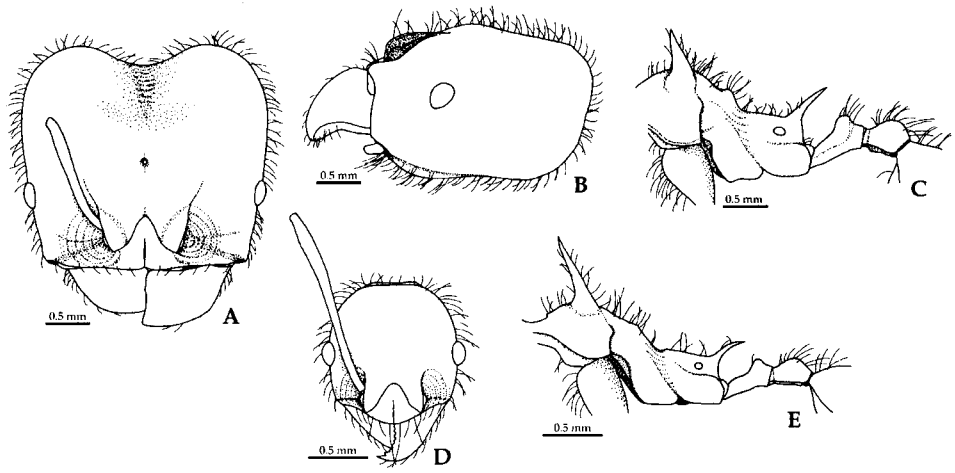

Fig. 24. ***Pheidole lokitae*** **Forel (Eg00-BOR-102): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

inconspicuous, extending backward to about midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape reaching about 2/3 distance of head; terminal segment 0.8-0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a pair of spines, with a conspicuous prominence on its posterior declivity (Fig. 24C); the prominence in anterior view not or very weakly concave medially. Mesopleuron without a conspicuous transverse impression. Propodeal spine long, ca. 6 times as long as diameter of propodeal spiracle, almost straight or downcurved, with narrow base (Fig. 24C). Petiole cuneiform, 1.4-1.5 times as long as postpetiole (excluding helcium); petiolar node in profile round and in posterior view emarginate at apex; subpetiolar process completely absent. Postpetiole 1.9-2.1 times as broad as petiolar node.

Anterior part of frons, and gena longitudinally rugose, with smooth and shining interspaces; posterior part of frons, vertex, and dorsal and lateral faces of occipital lobe reticulate, with smooth and shining enclosures; alitrunk irregularly rugoso-reticulate; petiole smooth and shining anterodorsally, weakly rugose and weakly shining posterodorsally, and punctured and dull laterally; postpetiole punctured and dull laterally, and transversely rugose dorsally; dorsum of gaster and anterior part of first gastral sternite distinctly rugoso-punctured and dull. Outer face of mandible sparsely covered with appressed hairs, which are 0.10-0.12 mm in length and shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer and decumbent hairs. Body dark reddish-brown with darker mandibles and gaster; legs a little lighter than alitrunk.

Minor Measurements and indices (n=5): TL 4.0-4.4 mm, HL 1.16-1.24 mm, HW 1.04-1.11 mm, SL 1.59-1.70 mm, AL 1.74-1.83 mm, FL 1.89-2.02 mm, CI 89-90, SI 153-155, FI 181-183. Head in full-face view oval (Fig. 24D); occipital carina distinct. Clypeus with a median longitudinal carina, with anterior margin in full-face view weakly convex medially. Eyes situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 1.1-1.2 times as long as

maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by more than its 1/3 length; terminal segment ca. 0.8 times as long as preceding two segments together. Promesonotum forming a dome with a pair of spine, with an inconspicuous prominence on its posterior declivity (Fig. 24E). Mesopleuron without a transverse impression. Propodeal spine long, 5-6 times as long as diameter of propodeal spiracle, almost straight or downcurved. Petiole in profile cuneiform, ca. 1.5 times as long as postpetiole (excluding helcium); petiolar node in posterior view weakly emarginate at apex; its posterior face usually margined dorsally and laterally. Postpetiole 2.1-2.3 times as broad as petiolar node.

Clypeus smooth and shining with several rugulae; remainder of head, and alitrunk reticulate; petiole weakly punctured laterally, smooth and shining anterodorsally, and very weakly punctured posterodorsally; postpetiole weakly punctured laterally and very weakly punctured dorsally; gaster smooth and shining. Body sparsely bearing standing hairs. Body dark reddish-brown with lighter mandibles; antennae and legs lighter than alitrunk.

Recognition *P. lokitae* is closely related to *P. quadrensis* Forel, *P. quadricuspis* Emery, *P. sperata* Forel, *P. acantha* sp. nov. and *P. spinicornis* sp. nov., and several undescribed species (see under *P. quadrensis*), and they are recognisable among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: promesonotum of both the subcastes armed with a pair of long and acute spines (Figs. 24C, E, 38D, E, G); hypostoma of the major bearing a pair of stout median processes (Fig. 38C). *P. lokitae*, *P. quadricuspis*, *P. quadrensis*, *P. acantha* sp. nov. and *P. spinicornis* sp. nov. are known from Borneo, and are distinguished from each other by the characters given in the key.

Distribution Borneo and Sumatra.

Bionomics This species seems to inhabit well-developed hill forests. The colony collected from Mahua Waterfall area (Eg00-BOR-102) nested inside a rotting fallen log, and stored up a number of tiny seeds in its nest.

24. *Pheidole longipes* (Fr. Smith) (Fig. 25)

Myrmica longipes Fr. Smith, 1857: 70, minor (BMNH). Type locality: Singapore. One syntype (minor) was examined.

Ischnomyrmex longipes: Mayr, 1862: 739.

Aphaenogaster longipes: Emery, 1895: 470.

Pheidole (Ischnomyrmex) longipes: Forel, 1913: 49.

Pheidole longipes: Bolton, 1995b: 324. Redescription: Eguchi, 1999: 97.

Subspecies enumerated in Bolton, 1995b: nominal plus *conicollis* Emery, 1900: 681, Sumatra; *continentis* Forel, 1911a: 24, Burma; *pseudola* Forel, 1915: 28, Sumatra (for these forms type material was not examined by me). Eguchi (1999) wrongly treated *Aphaenogaster (Ischnomyrmex) longipes* var. *laevior* Emery, 1887 as a subspecies of *P. longipes* without referring to Emery (1888) who raised the var. *laevior* to species rank. Later Emery (1915a) transferred it under *Aphaenogaster (Deromyrma)*.

Specimens examined BORNEO. Sabah, Malaysia: Poring, ca. 450-500 m alt., 2 majors and 16 minors (Eg96-BOR-265) / 600 m alt., 4 majors and 9 minors (6X2906-6-Ia, 6XII2306-26-Fb), TK / 900 m alt., 4 majors and 10 minors (B14, 7IV0310-5-Ga), TK; Sepilok forest, 5 majors and 9 minors (Eg98-BOR-879). Sarawak, Malaysia: Bt. Entimau (390 m alt.), 1 major and 1 minor (GC), Mahmud leg., 1994; Lambir Hills N. P., 1 major and 1 minor (GC), SKY, 1997 / 8 majors, 10 minors and 1 queen (Eg98-BOR-815); Bt. Lanjak, Engkari, 2 majors and 2 minors (GC), K. Het leg., 1994; Sg. Segerugok, Song, 1 major and 1 minor (GC), Abd. Rahman Nona leg., 1993. Brunei: Belalong Forest Section, 11 majors, 13 minors and 3

queens (Eg99-BOR-200, 216, 226). E. Kalimantan, Indonesia: Kutai N. P., 1 major and 1 minor (GC), SKY, 1993. MALAY PENINSULA. Malaysia: Ulu Gombak, 6 majors and 8 minors (FI92MG-555, FI96-736, FI99-109). Thailand: Ton Nga Chang N. P., Songkhla Prov., 1 major and 1 minor (GC), SKY, 1997. SINGAPORE. 1 major and 1 minor (GC), SKY, 1995. SUMATRA, Indonesia. Ulu Gadut, nr. Padang, W. Sumatra, 1 major (GC), E. Suzuki leg., 1989; Maninjau, W. Sumatra, 1 major (GC), SNS; Padang, W. Sumatra, 4 majors, 5 minors, 1 queen and 2 males (FI92-5).

Major Measurements and indices (n=32): TL 6.8-7.9 mm, HL 2.38-3.03 mm, HW 2.05-2.73 mm, SL 1.50-2.08 mm, FL 2.33-3.35 mm, CI 84-98, SI 63-96, FI 98-152. Head broadest at 2/3-3/4 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head in full-face view with a median emargination from which a shallow longitudinal impression extends to midlength of head (Fig. 25A); head in profile not impressed on vertex (Fig. 25B). Hypostoma bearing an inconspicuous median process, or lacking median processes. Clypeus with a median longitudinal carina, with anterior margin hardly emarginate medially. Eye situated around 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.7 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna without conspicuous club; scape extending backward to 2/3-9/10 distance of head. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 25C); the prominence in anterior view not or very weakly concave medially. Mesopleuron with an indistinct transverse impression. Propodeal spine corniform, 2.5-3 times as long as diameter of propodeal spiracle. Petiole in profile cuneiform, 1.0-1.1 times as long as postpetiole, with ill-defined node of which apex in posterior view is distinctly concave. Postpetiole in dorsal view subpentagonal, 2.0-2.2 times as broad as petiole.

Frons and gena longitudinally rugose; fine longitudinal rugulae curving outward on occipital lobes; lateral face of occipital lobe finely and weakly rugose with punctured interspaces, or smooth and shining over the surface; median portion of dorsolateral face of head rugoso-reticulate with enclosures punctured and dull; promesonotal dome smooth and shining, or in dorsal view weakly transversely rugose, with smooth and shining interspaces; remainder of alitrunk weakly punctured and smooth and shining partly, or weakly rugoso-reticulate, with punctured and dull enclosures; petiole (excluding smooth and shining anterodorsal face), postpetiole and first gastral tergite punctured and dull. Head in profile sparsely bearing standing hairs dorsally, and in full-face view bearing appressed pubescence, but lacking standing hairs (sometimes sparsely with them only on lateral face of occipital lobe) (Fig. 25A); outer face of mandible sparsely covered with appressed hairs, which are 0.03-0.06 mm in length and much shorter than distance between piligerous hairs; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs; in profile dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing less than 10 standing hairs (Fig. 25C). Body reddish-brown to dark reddish-brown; flagella and legs lighter than alitrunk.

Minor Measurements and indices (n=62): TL 4.1-5.1 mm, HL 1.04-1.54 mm, HW 0.66-0.93 mm, SL 1.67-2.38 mm, AL 1.50-2.11 mm, FL 2.10-3.04 mm, CI 58-70, SI 196-293, FI 247-372. Head in full-face view narrowed and prolonged behind eyes; occipital carina forming a distinct flange (Fig. 25D, E). Clypeus sometimes with a longitudinal median carina, with anterior margin slightly convex or truncate medially. Eye situated at about 4/9 distance of head (as measured from anterior margin of

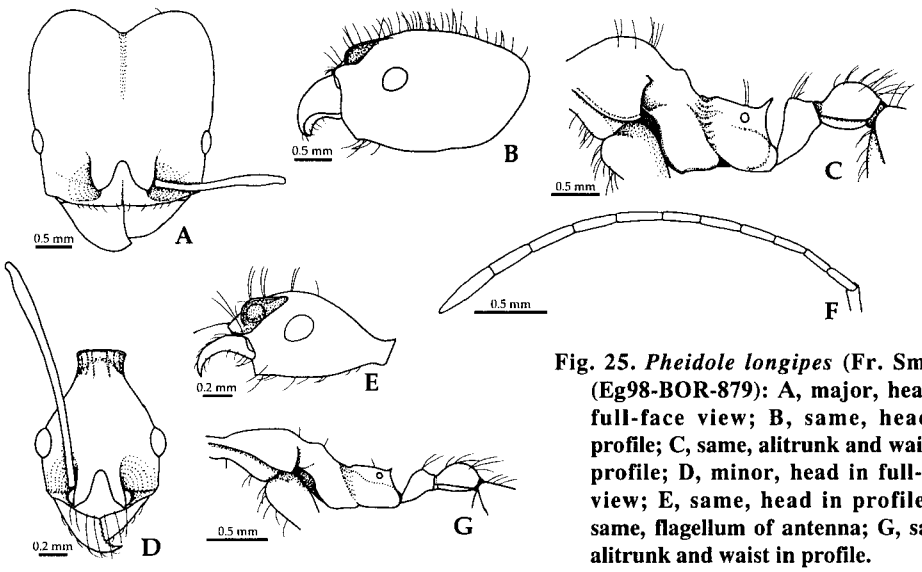

Fig. 25. *Pheidole longipes* (Fr. Smith) (Eg98-BOR-879): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, head in profile; F, same, flagellum of antenna; G, same, alitrunk and waist in profile.

clypeus to occipital carina); distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Antenna without conspicuous club (Fig. 25F), but 8th segment 1.3-1.4 times as long as 7th. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 25G). Mesopleuron without distinct transverse impression. Propodeal spine 2-2.5 times as long as diameter of propodeal spiracle. Petiole in profile cuneiform, with ill-defined node, 0.9-1.0 times as long as postpetiole. Postpetiole 2.0-2.3 times as broad as petiole, in dorsal view distinctly longer than broad, gently narrowed forward in its anterior 2/3.

Clypeus smooth and shining, or slightly punctured and with several rugulae; remainder of head and promesonotal dome smooth and shining; mesopleuron and lateral face of propodeum punctured (occasionally smooth and shining partly); lateral faces of petiole and postpetiole weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Body brown to dark brown (rarely light brown); legs lighter than alitrunk.

Recognition This species is closely related to *P. comata* Fr. Smith and *P. montana* Eguchi, and these three are peculiar among Indo-Chinese and Indo-Malayan congeners in the characteristics noted under *P. comata*. This species is distinguished from related species by the characteristics noted under *P. comata* and *P. montana*.

Distribution Indochina, Malay Peninsula, Borneo and Sumatra.

Bionomics This species inhabits well-developed forests, and nests in rotting fallen logs on the forest floor.

25. *Pheidole lucioccipitalis* sp. nov. (Fig. 26)

Holotype Major, colony: Eg96-BOR-292, Poring (500-550 m alt.), Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1996, deposited in UMS.

Paratypes 7 majors, 11 minors and 4 males from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 21 majors, 50 minors and 2 males (Eg96-BOR-111, 117, 124, 132, 145, 166, 188, 207, 211, 220); Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Poring, 450-500 m alt., 2 majors and 4 minors (Eg96-BOR-267) / 500-550 m alt., 2 majors and 4 minors (Eg96-BOR-293) / 560 m alt. (East Ridge), 2 minors (code AW-3), CB, 1995 / ca. 600 m alt., 15 majors, 21 minors, 2 queens and 1 male (06X2606-3-B, 6X2606-4-G, 6XI0106-16-2, 06XI0106-16-Ca; 06Q32S4; 87-A, 516, 525, 749A), TK / 700-800 m alt., 3 minors (GC), SKY, 1995 / ca. 900 m alt., 2 majors and 5 minors (7IV0310-5-1a, 7IV0310-5-2a.), TK / 1130 m alt. (East Ridge), 2 minors (code CW-2/3), CB, 1995; Sayap Kinabalu, 1 major and 2 minors (LS-6), SKY, 1996; Tawau Hills Park, 11 majors, 18 minors, 1 queen and 2 males (Eg96-BOR-013, 021, 030, 042) / 7 majors, 15 minors and 1 queen (SB96-SKY-07, 21; LS-2, 3; soil-11). Sarawak, Malaysia: Lambir Hills N. P., 5 majors and 4 minors (GC), SKY, 1993 / 1 major and 6 minors (GC), T. Itioka & T. Yumoto leg., 1994. Brunei: Belalong Forest Section, 9 majors, 10 minors and 1 queen (Eg99-BOR-207, 220, 223, 235). MALAY PENINSULA. Malaysia: Ulu Gombak, 19 majors, 28 minors and 2 males (FI92-MG-393; FI96-471, 576, 590, 601, 653; FI98-115, 132, 148, 163, 164; FI99-50). SUMATRA, Indonesia. Ulu Gadut, Padang, W. Sumatra, 7 majors, 12 minors, 1 queen and 2 males (FI97-382, 453, 458, 489, 517).

Major Measurements and indices (n=6): TL 2.4-2.5 mm, HL 1.06-1.14 mm, HW 1.02-1.08 mm, SL 0.55-0.61 mm, FL 0.75-0.80 mm, CI 94-96, SI 53-57, FI 72-76. Head broadest at 1/3-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 26A), in profile not impressed on vertex (Fig. 26B). Hypostoma with an indistinct median process (the process sometimes almost absent). Clypeus with a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.8 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to at most 2/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to 3/5-7/10 distance of head; terminal segment ca. 1.1 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome without any prominence on its posterior declivity (Fig. 26C); dorsal portion of the dome occasionally bordered anterodorsally with 2-3 transverse rugulae, weakly margined laterally. Mesopleuron divided by a distinct transverse impression into two parts, of which lower part occasionally margined dorsally. Propodeal spine horn-like, straight, almost twice as long as diameter of propodeal spiracle. Petiole cuneiform, 1.7-1.8 times as long as postpetiole (excluding helcium); petiolar node high, in posterior view not or slightly emarginate at apex. Postpetiole in dorsal view subhexagonal, 1.8-2.1 times as broad as petiolar node.

Dorsal and lateral faces of head excluding vertex and occipital lobe longitudinally rugose; remainder of head smooth and shining; promesonotal dome smooth and shining; mesopleuron and lateral face of propodeum punctured and weakly shining; lateral faces of petiolar pedicel and postpetiole weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with appressed hairs, which are 0.05-0.07 mm in length and almost as long as distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body yellowish-brown to brown, with darker gaster (sometimes mandibles and clypeus also darker); legs a little lighter than alitrunk.

Minor Measurements and indices (n=6): TL 1.6-1.8 mm, HL 0.50-0.53 mm, HW 0.44-0.48 mm, SL 0.55-0.59 mm, AL 0.71-0.78 mm, FL 0.58-0.65 mm, CI 86-89, SI 124-129, FI 131-142. Head in full-face view oval (Fig. 26D); occipital carina weak but complete. Clypeus without a median

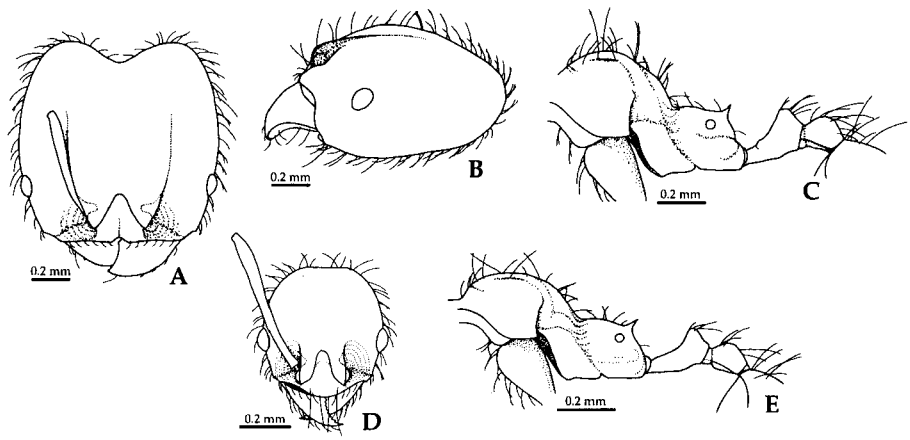

Fig. 26. *Pheidole lucioccipitalis* sp. nov. (type material: Eg96-BOR-292): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eyes situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.8-1.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 1/4 length; terminal segment 1.0-1.1 times as long as preceding two segments together. Promesonotal dome without any prominence on its posterior declivity; dorsal portion of the dome relatively flat (Fig. 26E), very weakly margined laterally, bordered anteriorly with 1-2 transverse rugulae. Mesopleuron with a weak transverse impression. Propodeal spine elongate-triangular, ca. 1.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.7-1.9 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole ca. 1.7 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; mesopleuron and lateral face of propodeum punctured; lateral face of petiolar pedicel very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body yellowish-brown with a little darker gaster; legs a little lighter than alitrunk.

Recognition This species is characterised among Indo-Chinese and Indo-Malayan congeners by a combination of the following characteristics: vertex and occipital lobe of the major smooth and shining; hypostoma of the major only with an indistinct median process (the process sometimes almost absent); promesonotal dome weakly or very weakly margined laterally, without any prominence on its posterior declivity in both the subcastes (Fig. 26C, E); petiole of the minor 1.7-1.9 times as long as postpetiole (Fig. 26E); occipital carina of the minor weak but complete (Fig. 26D).

Distribution Southern Malay Peninsula, Borneo and Sumatra.

26. *Pheidole manukana* sp. nov. (Fig. 27)

Holotype Major, Pulau Manukan (Tunku Abdul Rahman Park, off the coast of Kota Kinabalu), Sabah, E.

Malaysia (Borneo), Sk. Yamane leg., 1995, deposited in UMS.
Paratypes 3 majors and 5 minors, the same data as the holotype, deposited in BMNH and UMS.

Major Measurements and indices (n=4): TL 2.6-3.0 mm, HL 1.18-1.23 mm, HW 1.17-1.23 mm, SL 0.67-0.70 mm, FL 0.83-0.87 mm, CI 98-101, SI 55-58, FI 71-73. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 27A), in profile not impressed on vertex (Fig. 27B). Hypostoma without median processes. Clypeus with a weak median longitudinal carina, with anterior margin emarginate medially. Eye situated at or just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.6 times as long as maximal diameter of eye. Frontal carina conspicuous, extending backward to 2/3-3/4 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about 2/3 distance of head; terminal segment almost as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a low prominence on its posterior declivity (Fig. 27C); the prominence in anterior view not or very weakly concave medially. Mesopleuron without a distinct transverse impression. Propodeal spine 2.5-3 times as long as diameter of propodeal spiracle. Petiole cuneiform, almost as long as postpetiole (excluding helcium) (Fig. 27E); petiolar node low, in profile acute and in posterior view weakly and broadly emarginate at apex. Postpetiole in dorsal view subpentagonal, 2.4-2.6 times as broad as petiolar node.

Frons and anterior 2/3 of lateral face of head sparsely longitudinally rugose; dorsum of occipital lobe smooth and shining, or weakly rugoso-reticulate, and lateral face of the lobe smooth and shining; promesonotal dome smooth and shining with several transverse rugulae dorsally; remainder of alitrunk, and petiole and postpetiole largely smooth and shining; gaster smooth and shining. Outer face of mandible covered with decumbent hairs, which are 0.05-0.09 mm in length and longer than distance between piligerous punctures. Body reddish-brown with a little darker gaster.

Minor Measurements and indices (n=5): TL 1.8 mm, HL 0.59-0.65 mm, HW 0.54-0.62 mm, SL 0.67-0.71 mm, AL 0.79-0.86 mm, FL 0.70-0.76 mm, CI 92-95, SI 115-124, FI 120-130. Head in full-face view subrectangular (Fig. 27D); occipital carina weak but complete. Clypeus without a median longitudinal carina, with anterior margin in full-face view weakly concave medially. Eyes situated at about midlength of head; distance between mandibular insertion and anterior margin of eye ca. 0.9 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior margin of head by 1/4 length of scape; terminal segment 0.9-1.0 times as long as preceding two segments together. Promesonotum forming a low dome with a pair of inconspicuous tubercles dorsolaterally, with an inconspicuous prominence or without any prominence on its posterior declivity toward inconspicuous metanotal groove (Fig. 27E). Mesopleuron without a distinct transverse impression. Propodeal spine elongate-triangular, almost twice as long as diameter of propodeal spiracle. Petiole cuneiform, almost as long as postpetiole (excluding helcium) (Fig. 27E); petiolar node low, in profile acute and in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, ca. 2.2 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; remainder of alitrunk, and petiole and postpetiole largely smooth and shining; gaster smooth and shining. Body brown.

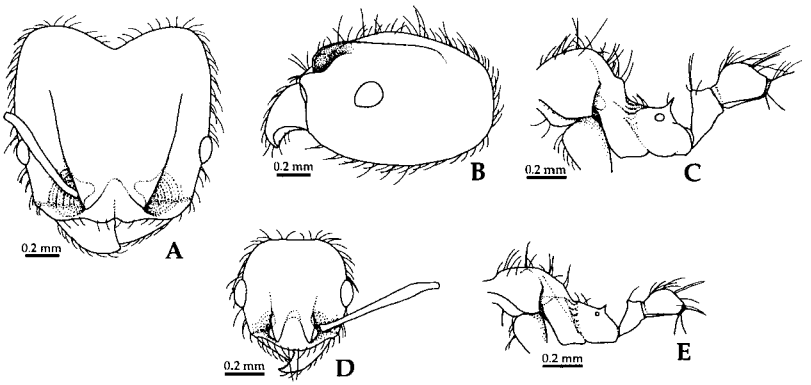

Fig. 27. *Pheidole manukana* sp. nov. (type material: Pulau Manukan, SKY, 1995): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

Recognition This species is distinguished from other Indo-Malayan congeners by a combination of the following characteristics: hypostoma of the major without median process; dorsum of occipital lobe of the major almost smooth and shining; head of the minor subrectangular with a weak but complete occipital carina (Fig. 27D); prominence on the posterior declivity of promesonotum inconspicuous or absent in the minor (Fig. 27E); petiole almost as long as postpetiole in both the subcastes (Fig. 27C, E); postpetiole wide, 2.4-2.6 times as broad as petiolar node in the major and ca. 2.2 times in the minor.

Distribution Borneo.

27. *Pheidole megacephala* (Fabricius) (Fig. 28)

Formica megacephala Fabricius, 1793: 361, major. No locality given. Combination in *Pheidole*: Roger, 1863: 30. Type material not examined by me.

Myrmica trinodis Losana, 1834: 327, "worker". Type locality: Italia. Junior synonym of *P. megacephala*: Roger, 1863: 30. Type material not examined by me.

Formica edax Forskål, 1775: 84, "worker". Type locality: Egypt. Junior synonym of *P. megacephala*: Emery, 1892: 160; Dalla Torre, 1892: 90. Type material not examined by me.

Oecophthora perniciosa Gerstäcker, 1859: 263, "worker". Type locality: Mozambique. Junior synonym of *P. megacephala*: Emery, 1915c: 235. Type material not examined by me.

Oecophthora pusilla Heer, 1852: 15, major, minor, queen and male. Type locality: Madeira. Senior synonym of *P. janus* Fr. Smith, 1858b: Mayr, 1886: 360; *Myrmica laevigata* Fr. Smith, 1855: Roger, 1859: 259; and *P. laevigata* Mayr, 1862: Mayr, 1870: 981. Junior synonym of *P. megacephala*: Wheeler, 1922a: 812. Type materials not examined by me.

Myrmica suspiciosa Fr. Smith, 1859: 148, "worker". Type locality: Aru I. (Indonesia). Junior synonym of *P. megacephala*: Donisthorpe, 1932: 455. Type material not examined by me.

Atta testacea Fr. Smith, 1858b: 168, major and minor. Type locality: Brazil. Junior synonym of *P. megacephala*: Brown, 1981: 530. Type material not examined by me.

Subspecies enumerated in Bolton, 1995b: nominal plus *costauriensis* Santschi, 1914: 443, Ghana; *duplex* Santschi, 1937a: 220, Angola; *ilgi* Forel, 1907: 82, Ethiopia; *impressifrons* Wasmann, 1905: 110, South Africa; *melancholica* Santschi, 1912: 164, Ivory Coast; *nkomoana* Forel, 1916: 415, Zaire; *rotundata* Forel, 1894: 92, Mozambique; *scabrior* Forel, 1891: 178, Madagascar; *speculifrons* Stitz, 1911: 386, Tanzania; *talpa* Gerstäcker, 1871: 356, Kenya (for these forms type material was not examined by me).

Specimens examined BORNEO. Sabah, Malaysia: Danum Valley (in the Headquarters), 5 majors and 10 minors (Eg96-BOR-108); nr. Kota Kinabalu, 6 majors and 11 minors (Eg97-BOR-376); Tambunan Village

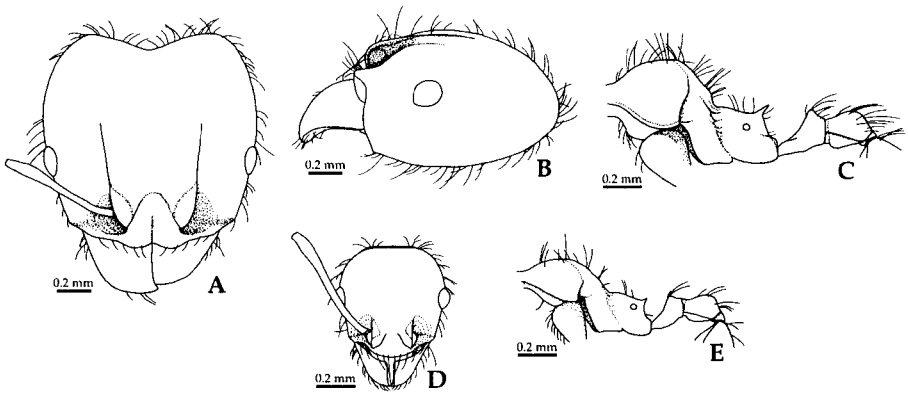

Fig. 28. ***Pheidole megacephala*** **(Fabricius) (Eg96-BOR-108): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

Resort Centre, 1 minor (GC), HO, 2000. Sarawak, Malaysia: Bako N. P., 4 minors (GC), SKY, 1993. S. CHINA. Hongkong: Victoria Park, Hongkong I., 1 major (GC), KE, 1999. Macau: Mong-Ha, 1 minor (GC), KE, 1999. NEW GUINEA. Irian Jaya, Indonesia: Wamena (1600 m alt.), 12 majors, 20 minors and 1 queen (Eg98-IRI-674, 675, 676, 703).

Major Measurements and indices (n=5): TL 2.9-3.3 mm, HL 1.25-1.34 mm, HW 1.25-1.33 mm, SL 0.68-0.72 mm, FL 0.88-0.94 mm, CI 97-101, SI 53-55, FI 70-72. Head broadest at about 3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head weakly concave (Fig. 28A); head in profile not impressed on vertex (Fig. 28B). Hypostoma without median processes. Clypeus usually with a weak median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 2/5 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.6 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to at most 3/5 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about 2/3 distance of head; terminal segment ca. 0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome only with an inconspicuous prominence on its posterior declivity (Fig. 28C); each dorsolateral portion of the dome very weakly produced outward. Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, straight, almost twice as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.2 times as long as postpetiole (excluding helcium); petiolar node in posterior view weakly emarginate at apex. Postpetiole in dorsal view subpentagonal, 1.8-1.9 times as broad as petiolar node; anteroventral corner weakly produced.

Dorsal and lateral faces of head excluding vertex and occipital lobe longitudinally rugose; remainder of head smooth and shining; promesonotal dome smooth and shining with several transverse rugulae dorsally; remainder of alitrunk, and lateral faces of petiole and postpetiole punctured weakly and dull; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with appressed hairs, which are 0.02-0.07 mm in length and a little shorter than distance between piligerous punctures; submarginal zone of masticatory margin of

mandible with a row of longer decumbent hairs. Body brown with a little lighter lateral face of alitrunk; legs lighter than alitrunk.

Minor Measurements and indices (n=5): TL 1.8-2.2 mm, HL 0.58-0.67 mm, HW 0.53-0.60 mm, SL 0.63-0.69 mm, AL 0.80-0.90 mm, FL 0.64-0.73 mm, CI 88-92, SI 115-122, FI 121-126. Head in full-face view oval (Fig. 28D); occipital carina distinct. Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate medially. Eyes situated just behind midlength of head; distance between mandibular insertion and anterior margin of eye almost as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior margin of head by 1/4 length of scape; terminal segment ca. 0.9 times as long as preceding two segments together. Promesonotum forming a low dome, without any distinct prominence on its posterior declivity toward inconspicuous metanotal groove (Fig. 28E). Mesopleuron without a transverse impression. Propodeal spine elongate-triangular, almost as long as diameter of propodeal spiracle. Petiole cuneiform, 1.1-1.2 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, 1.7-1.9 times as broad as petiolar node; anterodorsal declivity in profile gentler than posterodorsal one.

Head including clypeus and promesonotum smooth and shining; mesopleuron and lateral face of propodeum punctured weakly and dull; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body colour pattern similar to that of the major.

Recognition This medium-sized species is characterised by a combination of the following conditions: vertex and occipital lobe of the major smooth and shining; hypostoma of the major lacking median processes; posterior declivity of promesonotal dome lacking a distinct prominence in both the subcastes (Fig. 28C, E); petiole ca. 1.2 times as long as postpetiole in both the subcastes (Fig. 28C, E).

Distribution This species apparently is native to Africa, and has been spread by commerce to almost all of the more humid parts of the tropics (Wilson & Taylor, 1967).

Bionomics This species inhabits urban and man-made habitats.

28. *Pheidole merimbun* sp. nov. (Fig. 29)

Holotype Major, colony: Eg99-BOR-086, Merimbun Heritage Park, BRUNEI, K. Eguchi leg., 1999, deposited in MBD.

Paratypes 3 majors and 4 minors from the same colony to which the holotype belongs, deposited in BMNH, MBD and UMS.

Major Measurements and indices (n=4): TL 2.3-2.6 mm, HL 1.00-1.08 mm, HW 0.90-0.95 mm, SL 0.45-0.48 mm, FL 0.59-0.60 mm, CI 88-90, SI 47-51, FI 63-66. Head broadest at about 3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 29A), in profile slightly impressed on vertex (Fig. 29B). Hypostoma bearing three median processes, of which medianmost one is poorly developed. Clypeus without a median longitudinal carina, with anterior margin very weakly concave medially. Eye situated just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye ca. 1.5 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to 3/5-2/3 distance of head. Antennal scrobe inconspicuous, running along frontal

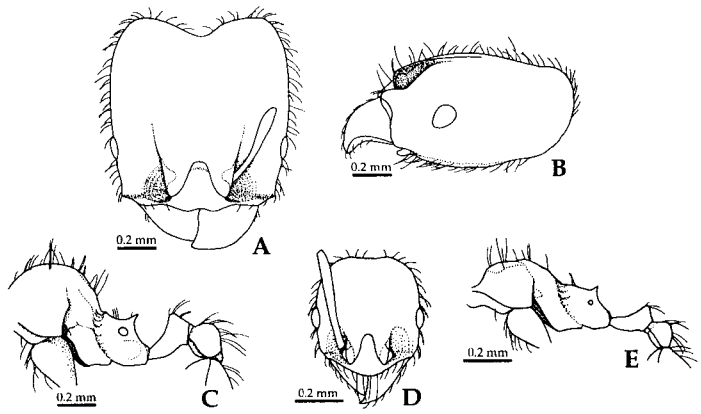

Fig. 29. *Pheidole merimbun* sp. nov. (type material: Eg99-BOR-086): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

carina. Antenna with 3-segmented club; scape extending backward to 3/5-2/3 distance of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity (Fig. 29C); each dorsolateral portion of the dome produced outward. Mesopleuron with a weak transverse impression. Propodeal spine elongate triangular, broadly based, 1.5-2 times as long as diameter of propodeal spiracle. Petiole 1.5-1.6 times as long as postpetiole (excluding helcium); petiolar node in posterior view slightly emarginate at apex. Postpetiole 1.6-1.7 times as broad as petiolar node.

Frons, vertex and gena longitudinally rugose; occipital lobe completely smooth and shining; dorsum of promesonotal dome smooth and shining with several transverse rugulae; lateral face of promesonotal dome smooth and shining; lower part of mesopleuron partly smooth and shining; remainder of alitrunk weakly punctured and weakly shining; lateral faces of petiole and postpetiole very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with very short appressed hairs, which are ca. 0.03 mm in length and much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body yellowish-brown with darker mandible, clypeus and gaster.

Minor Measurements and indices (n=4): TL 1.5-1.6 mm, HL 0.48-0.50 mm, HW 0.43-0.45 mm, SL 0.41-0.42 mm, AL 0.61-0.63 mm, FL 0.43-0.45 mm, CI 89-95, SI 92-95, FI 94-101. Head in full-face view weakly convex posteriorly (Fig. 29D); occipital carina evanescent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view almost truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye ca. 0.9 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape slightly extending beyond posterior border of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotum relatively low and flat dorsally (Fig. 29E), in dorsal view very

weakly margined laterally, without a prominence on its posterior declivity. Mesopleuron without a distinct transverse impression. Propodeal spine small, pointed, almost twice as long as diameter of propodeal spiracle. Petiole 1.6-1.7 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole ca. 1.5 times as broad as petiolar node.

Clypeus and frons smooth and shining; remainder of dorsum of head sparsely sculptured by evanescent longitudinal rugulae and shining; promesonotal dome smooth and shining, with several rugulae anteriorly and laterally; remainder of alitrunk punctured; lateral face of petiolar pedicel weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body yellowish-brown.

Recognition This species, together with *P. planidorsum* sp. nov., has a combination of the following characteristics: promesonotal dome of the minor relatively low and flat dorsally (Figs. 29E, 35F); hypostoma of the major bearing three median processes (medianmost one poorly developed in this species); posterior declivity of promesonotal dome without a distinct prominence in both the subcastes (Fig. 29C, E); occipital carina of the minor almost absent dorsally on head (Fig. 29D); body relatively small. This species is closely related to *P. planidorsum* sp. nov., but in the latter occipital lobe of the major is reticulate.

Distribution Borneo.

29. *Pheidole modiglianii* Emery (Figs. 30, 60)

Pheidole modiglianii Emery, 1900: 684, major, minor and queen (MCSN). Type locality: Mentawai, Indonesia. Redescription of type material: Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 8 minors (GC), HO, 1995 / 5 minors (GC), SKY, 1995; 4 majors and 8 minors (GC), CB, 2000; Gunong Rara (4°58'N 117°8'E, ca. 250 m alt.), 3 majors and 10 minors (Eg96-BOR-306). MALAY PENINSULA. Malaysia: Ulu Gombak, 1 major and 3 minors (FI92MG-182; FI96-719). SUMATRA, Indonesia. Muko Muko (ca. 470 m alt.), Maninjau, W. Sumatra, 4 majors and 7 minors, SNS; Sako, nr. Tapan, W. Sumatra, 1 minor, SNS; Ulu Gadut, nr. Padang, W. Sumatra, 8 majors and 11 minors (FI96-118, FI97-442) / 1 minor, SNS. MENTAWAI IS., Indonesia. Pulau Sipora, 10 minors, SNS.

Major Measurements and indices (n=4): TL 4.3-5.0 mm, HL 1.88-2.08 mm, HW 2.00-2.18 mm, SL 1.13-1.18 mm, FL 1.70-1.78 mm, CI 105-106, SI 53-57, FI 80-85. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 30A), in profile not impressed on vertex (Fig. 30B). Hypostoma with three median processes, of which medianmost one is lower. Clypeus with a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye ca. 2.0 times as long as maximal diameter of eye. Frontal carina weak, extending backward to about 3/4 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape reaching about 3/4 distance of head; terminal segment ca. 0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a low prominence on its posterior declivity (Fig. 30C); the prominence in anterior view not concave medially. Mesopleuron with an inconspicuous transverse impression. Propodeal spine horn-like, exceptionally long, extending above petiolar node (Fig. 30C). Petiole cuneiform, 1.5-1.6 times as long as postpetiole (excluding helcium); petiolar node very low, in posterior view slightly emarginate at apex. Postpetiole 1.5-1.7 times as broad as petiolar node.

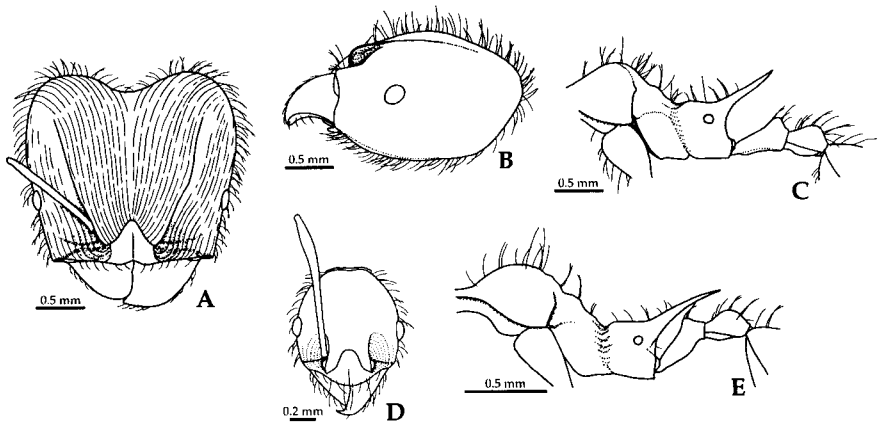

Fig. 30. ***Pheidole modiglianii*** **Emery (Eg96-BOR-306): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

Frons longitudinally rugose, with smooth and shining interspaces; longitudinal rugulae curving outward on occipital lobes (Fig. 30A); anterolateral face of head rugoso-reticulate; dorsum of promesonotum transversely rugose, with smooth and shining interspaces; mesopleuron and lateral face of propodeum rugoso-reticulate, with enclosures punctured and very weakly shining; lateral face of petiole punctured; dorsum of petiole smooth and shining; postpetiole smooth and shining, or partly punctured and dull; gaster smooth and shining. Outer face of mandible sparsely covered with appressed hairs, which are 0.04-0.10 mm in length and almost as long as, or shorter than, distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body dark reddish-brown with darker head (excluding mandible and anterior 1/3 of head) and gaster; flagella and tarsi lighter than alitrunk.

Minor Measurements and indices (n=5): TL 3.3-3.5 mm, HL 0.88-0.98 mm, HW 0.77-0.87 mm, SL 1.10-1.13 mm, AL 1.33-1.47 mm, FL 1.34-1.43 mm, CI 85-88, SI 131-143, FI 165-177. Head in full-face view oval (Fig. 30D); occipital carina well developed. Clypeus usually with a distinct median longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eyes situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 1.1-1.2 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 1/3 length; terminal segment ca. 0.8 times as long as preceding two segments together. Promesonotal dome with a low prominence on its posterior declivity (Fig. 30E). Mesopleuron without a transverse impression. Propodeal spine horn-like, exceptionally long, extending beyond posterior node (Fig. 30E). Petiole in profile elongate cuneiform, 1.4-1.5 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole ca. 1.7 times as broad as petiolar node.

Clypeus sparsely rugose (interspaces occasionally very weakly punctured and weakly shining); area between antennal insertion and eye weakly punctured and with several rugulae; remainder of head largely smooth and shining; in dorsal view promesonotal dome (excluding irregularly rugose

central part) concentrically rugose with interspaces punctured very weakly and shining; mesopleuron and propodeum rugoso-reticulate, with weakly punctured enclosures; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body dark reddish-brown with lighter alitrunk; flagella and tarsi lighter than alitrunk.

Recognition This relatively large-sized species is characterised by its exceptionally long propodeal spine in both the subcastes (Fig. 30C, E).

Distribution Southern Malay Peninsula, Borneo, Sumatra and Mentawai Is. (Fig. 60).

Bionomics This species inhabits lowland rainforests. It is very rare on the ground, while I found two nests in trunks of newly logged trees in Danum Valley, and a migrating column near a newly logged tree in Gunong Rara. Thus this species is very probably arboreal.

30. *Pheidole montana* Eguchi (Fig. 31)

Pheidole montana Eguchi, 1999: 100-102, major, minor and queen (UMS, MNHA). Type locality: Mt. Kinabalu (nr. Park Headquarters, ca. 1500 m alt.), Sabah, Borneo.

Specimens examined BORNEO. Sabah, Malaysia: Poring, ca. 1200 m alt., 19 minors (123B, B137), TK / 1530 m alt. (East Ridge), 1 minor (code EW-2), CB, 1995 / 1740 m alt. (East Ridge), 1 minor (code FB-3), CB, 1995; Kinabalu Park Headquarters area, 1500 m alt., 2 majors, 71 minors and 2 queens (116Aa, 116b, 126L, 130A, 152A, 167A, 169A, 184A, 207, 212A, 297A, 592A; 7IV11147-7A4), TK / 15 minors (GC), SKY, 1995 / ca. 1800 m alt., 1 major and 19 minors (Eg97-BOR-387, 407; Eg98-BOR-846) / 2 majors and 10 minors (676A), TK.

Major Measurements and indices (n=8): TL 5.8-6.3 mm, HL 2.37-2.70 mm, HW 2.32-2.53 mm, SL 1.60-1.72 mm, FL 2.63-2.87 mm, CI 93-100, SI 64-71, FI 108-117. Head broadest at 3/5-7/10 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head in full-face view with median emargination from which an inconspicuous longitudinal impression extends to midlength of head (Fig. 31A); head in profile not impressed on vertex (Fig. 31B) Hypostoma without median processes. Clypeus with a median longitudinal carina, with anterior margin weakly emarginate medially. Eye situated around 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.7-1.8 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna without conspicuous club; scape extending backward to 4/5 distance of head. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 31C); the prominence in anterior view not or very weakly concave medially. Mesopleuron with an indistinct transverse impression. Propodeal spine corniform, 3.5-4 times as long as diameter of propodeal spiracle. Petiole in profile cuneiform, almost as long as postpetiole, with ill-defined node of which apex is in posterior view distinctly concave. Postpetiole in dorsal view subpentagonal, 2.2-2.5 times as broad as petiole.

Frons and gena longitudinally rugose; dorsum of occipital lobe with fine longitudinal rugulae curving outward, and with interspaces weakly punctured and dull; lateral face of occipital lobe finely and weakly rugose, sometimes with punctured interspaces; median portion of dorsolateral face of head rugoso-reticulate with enclosures punctured and dull; promesonotal dome smooth and shining; remainder of alitrunk largely punctured very weakly and shining; lateral faces of petiole and postpetiole very weakly punctured and shining; dorsa of petiole and postpetiole punctured very

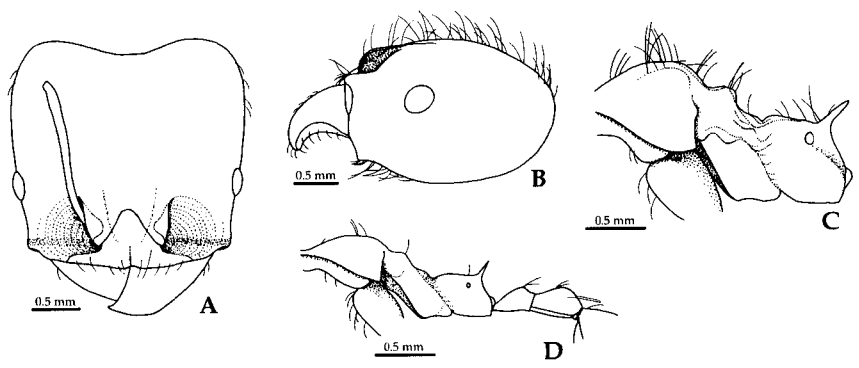

Fig. 31. ***Pheidole montana*** **Eguchi (Eg98-BOR-847): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk in profile; D, minor, alitrunk and waist in profile.**

weakly, or smooth and shining; gaster smooth and shining. Dorsal face of head (including occipital lobe) and lateral face of occipital lobe bearing standing hairs (Fig. 31A); outer face of mandible sparsely covered with appressed to decumbent hairs, which are 0.05-0.08 mm in length and shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs; in profile dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing 10-20 standing hairs (Fig. 31C). Body yellowish-brown, brown, or reddish-brown; legs lighter than alitrunk.

Minor Measurements and indices (n=162): TL 3.5-4.8 mm, HL 0.92-1.42 mm, HW 0.62-0.99 mm, SL 1.28-1.95 mm, AL 1.27-1.93 mm, FL 1.57-2.51 mm, CI 64-73, SI 172-227, FI 226-280. Head in full-face view narrowed and prolonged behind eyes toward occipital carina which forms a distinct flange. Clypeus with a weak longitudinal median carina, with anterior margin slightly convex or truncate medially. Eye situated at 4/9-1/2 distance of head (as measured from anterior margin of clypeus to occipital carina); distance between mandibular insertion and anterior margin of eye 1.1-1.3 times as long as maximal diameter of eye. Antenna without conspicuous club, but 8th segment 1.3-1.4 times as long as 7th. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 31D). Mesopleuron without a distinct transverse impression. Propodeal spine 4-5 times as long as diameter of propodeal spiracle (Fig. 31D). Petiole in profile cuneiform, with ill-defined node, 0.8-0.9 times as long as postpetiole. Postpetiole 2.2-2.3 times as broad as petiole, in dorsal view distinctly longer than broad, gently narrowed forward in its anterior 2/3.

Head including clypeus and promesonotum smooth and shining; remainder of alitrunk largely smooth (or very weakly punctured) and shining; lateral faces of petiole and postpetiole smooth and shining, or very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Body light brown to brown, with a little darker head and gaster.

Recognition This species is closely related to *P. comata* Fr. Smith and *P. longipes* (Fr. Smith), and all these are peculiar among Indo-Chinese and Indo-Malayan congeners in the characteristics noted under *P. comata*. Diagnostic characteristics of this species which separate it from *P. longipes* are: propodeal spine horn-like, more than 3.5 times as long as diameter of propodeal spiracle in the major (Fig. 31C) and more than 4 times in the minor (Fig. 31D); in profile dorsum of promesonotal dome in

front of the prominence on its posterior declivity bearing 10-20 standing hairs in the major (Fig. 31C). Body yellowish-brown to brown in the minor. This species is distinguished from *P. comata* by the characters noted under *P. comata*.

Distribution Borneo.

Bionomics This species inhabits well-developed hill forests. I found its nests in the soil, and many colonies were collected from rotting logs by TK.

31. *Pheidole orophila* sp. nov. (Figs. 32, 62)

Holotype Major, colony: Eg00-WM-001, Cameron Highlands (ca. 1500 m alt.), W. Malaysia (Southern Malay Peninsula), K. Eguchi leg., 2000, deposited in FRIM.

Paratypes 14 majors and 15 minors from the same colony to which the holotype belongs, deposited in BMNH, FRIM, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Mt. Kinabalu, ca. 1500 m alt., 8 majors, 25 minors, 3 queens and 2 males (7IV1114-5-B1; 118Ae, 126A, 211A, 230A), TK; Mahua Waterfall area, 4 majors and 4 minors (Eg00-BOR-113). MALAY PENINSULA. Malaysia: Cameron Highlands (ca. 1000 m alt.), 2 majors and 8 minors (FI92MCH-7, 19, 49) / 5 majors, 6 minors and 1 queen (Eg00-WM-002). SUMATRA, Indonesia. Sukarami, Padang, W. Sumatra, 2 majors and 5 minors (9/29b), MK, 1999. JAVA, Indonesia. G. Halimun, 3 majors, 4 minors, 1 queen and 1 male (FI96-299).

The following description and measurements are based on the holotype and paratypes.

Major Measurements and indices (n=5): TL 3.0-3.3 mm, HL 1.15-1.23 mm, HW 1.08-1.17 mm, SL 0.88-0.91 mm, FL 1.15-1.17 mm, CI 93-96; SI 77-84, FI 100-107. Head broadest about 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 32A); head in profile not impressed on vertex (Fig. 32B). Hypostoma with three low median processes, of which medianmost one is inconspicuous. Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.5-1.7 times as long as maximal diameter of eye. Frontal carina weak or inconspicuous, extending backward to 2/3-7/10 distance of head. Antennal scrobe inconspicuous, running along frontal carina. Antenna with 3-segmented club; scape extending backward to about 4/5-9/10 distance of head; terminal segment 0.9-1.0 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 32C); the prominence in anterior view not concave medially. Mesopleuron divided by a transverse impression into two parts, of which lower part is weakly margined dorsally. Propodeal spine horn-like, narrowly based, 2-2.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.4-1.5 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole 1.6-1.9 times as broad as petiolar node.

Dorsum of head longitudinally rugose, with interspaces weakly, or very weakly, punctured; lateral face of occipital lobe very weakly punctured and weakly shining; promesonotal dome smooth and shining largely; upper part of mesopleuron and lateral face of propodeum weakly punctured with several rugulae; lower part of mesopleuron smooth and shining largely; lateral faces of petiole and postpetiole very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with appressed to decumbent hairs, which are 0.05-0.09 mm in length and as long as, or a little longer than, distance between piligerous punctures. Body light brown with darker alitrunk.

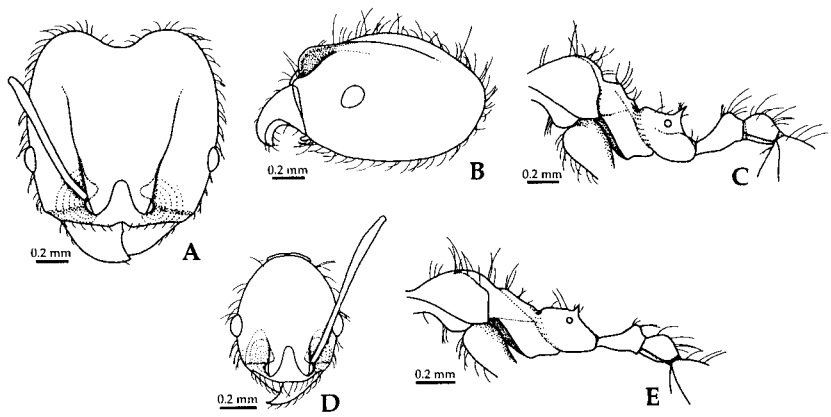

Fig. 32. ***Pheidole orophila*** **sp. nov. (type material: Eg00-WM-001): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

Minor Measurements and indices (n=5): TL 2.3-2.5 mm, HL 0.69-0.73 mm, HW 0.55-0.56 mm, SL 0.88-0.91 mm, AL 1.01-1.07 mm, FL 1.00-1.03 mm, CI 77-80, SI 159-163, FI 180-185. Head in full-face view oval (Fig. 32D); occipital carina well developed. Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate or slightly concave medially. Eyes situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 1.0-1.1 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 3/10-1/3 length; terminal segment ca. 0.9 times as long as preceding two segments together. Promesonotal dome with a low prominence on its posterior declivity (Fig. 32E). Mesopleuron with an inconspicuous transverse impression. Propodeal spine 1.5-2 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.4 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole 1.6-1.7 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; mesopleuron and lateral face of propodeum weakly punctured and weakly shining; lateral faces of petiole and postpetiole very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Body light-brown or yellowish-brown.

Variation There are no significant morphological differences between specimens from S. Malay Peninsula (type locality) and those from Borneo.

Recognition This medium-sized species with a general habitus is most similar to *P. fervens* Fr. Smith among the known Indo-Malayan congeners, but in the latter frontal carina of the major is distinct, lateral face of occipital lobe of the major is rugoso-reticulate and CI of the minor is 82-87.

Distribution Southern Malay Peninsula, Borneo, Sumatra and Java (Fig. 62).

32. *Pheidole parvicorpus* sp. nov. (Fig. 33)

Holotype Major, colony: Eg97-BOR-584, Gunong Rara (4°58'N 117°8'E, ca. 250 m alt.), Sabah, E.

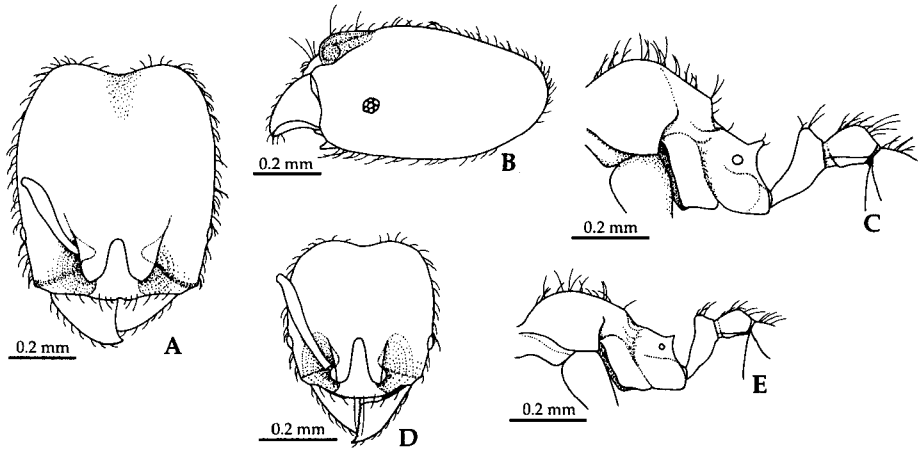

Fig. 33. ***Pheidole parvicorpus*** **sp. nov. (type material: Eg97-BOR-584): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

Malaysia (Borneo), K. Eguchi leg., 1997, deposited in UMS.

Paratypes 9 majors, 16 minors and 2 queens from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS..

Other specimens examined BORNEO. Sabah, Malaysia: Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Gunong Rara, 6 majors and 15 minors (Eg97-BOR-585). Sarawak, Malaysia: Kubah N. P., 12 majors and 6 minors (GC), SKY, 1993 and 1994; Semengoh N. P., 6 majors, 7 minors, 12 queens and 1 male (GC), SKY, 1993.

Major Measurements and indices (n=6): TL 1.7-1.9 mm, HL 0.64-0.74 mm, HW 0.53-0.60 mm, SL 0.28-0.30 mm, FL 0.37-0.40 mm, CI 81-83, SI 47-56, FI 64-73. Head broadest at 1/2-3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); in full-face view posterior margin of head shallowly concave (Fig. 33A); head in profile at most very weakly impressed on vertex (Fig. 33B). Hypostoma bearing a pair of distinct median processes. Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated just in front of 1/3 distance of head, consisting of 5-7 ommatidia (Fig. 33B). Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to 1/2-5/9 distance of head; terminal segment 1.6-1.7 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with an inconspicuous prominence on its posterior declivity (Fig. 33C). Mesopleuron without a distinct transverse impression. Propodeal spine almost twice as long as diameter of propodeal spiracle. Petiole 1.6-1.7 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole 1.4-1.5 times as broad as petiolar node.

Dorsum of head above subocular level weakly rugose longitudinally and weakly shining; upper part of mesopleuron dull; dorsum of propodeum punctured; remainder of alitrunk smooth and shining largely; lateral face of petiole very weakly punctured and weakly shining; dorsum of petiole, and postpetiole and gaster smooth and shining. Outer face of mandible sparsely covered with appressed to

decumbent hairs, which are 0.02-0.04 mm in length and a little shorter than distance between piligerous punctures. Body light yellowish-brown with darker mandibles.

Minor Measurements and indices (n=6): TL 1.1-1.3 mm, HL 0.38-0.42 mm, HW 0.37-0.39 mm, SL 0.24-0.27 mm, AL 0.46-0.49 mm, FL 0.29-0.31 mm, CI 92-96, SI 65-71, FI 78-81. Head in full-face view weakly concave posteriorly (Fig. 33D); occipital carina absent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eye situated at about 2/5 distance of head (as measured from the anteriormost to posteriormost of head), consisting of 5-6 ommatidia. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about 5/6 distance of head; terminal segment 1.6-1.7 times as long as preceding two segments together. Promesonotum low, relatively flat dorsally (Fig. 33E). Mesopleuron with a weak transverse impression. Propodeal spine ca. 1.5 times as long as diameter of propodeal spiracle. Petiole 1.6-1.7 times as long as postpetiole (excluding helcium). Postpetiole 1.5-1.6 times as broad as petiolar node.

Clypeus almost smooth, or very weakly punctured and weakly shining; remainder of dorsum of head above subocular level weakly rugose longitudinally and weakly shining; venter of head below subocular level largely smooth and shining; remainder of body largely smooth and shining. Body yellow to light yellowish-brown.

Recognition This tiny species is peculiar among Indo-Malayan small-sized congeners in the following conditions: eye consisting of 5-7 ommatidia in both the subcastes (Fig. 33B); terminal antennal segment more than 1.6 times as long as preceding two segments together in both the subcastes.

Distribution Borneo.

Bionomics This species inhabits well-developed lowland forests, and nests in rotting wood.

33. *Pheidole plagiaria* Fr. Smith (Figs. 34, 56)

Pheidole plagiaria Fr. Smith, 1860: 112, major and minor. Type locality: Batjan, INDONESIA. Type material not examined.

Pheidole divergens Mayr, 1867: 97, major, minor, queen and male. Type locality: INDONESIA. Junior synonym of *P. plagiaria*: Mayr, 1879: 675. Type material not examined.

Subspecies enumerated in Bolton, 1995b: nominal plus *moica* Forel, 1911d: 222, Vietnam; *palawanica* Stitz, 1925: 118, Palawan; *rectilineata* Viehmeyer, 1916b: 288, Sulawesi (for these forms type material was not examined by me).

Specimens examined BORNEO. Sabah, Malaysia: Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Gunong Rara, 12 majors, 31 minors and 1 queen (Colony: Eg96-BOR-351, 363; Eg97-BOR-526, 534, 556, 566); Poring, 450-500 m alt., 3 majors and 5 minors (Eg96-BOR-271) / 500-550 m alt., 1 major and 5 minors (Eg96-BOR-294) / ca. 600 m alt., 11 majors and 18 minors (8-A, 43A, 731, 6XI2306S1-4), TK; Sepilok forest, 11 majors, 19 minors and 1 queen (Eg97-BOR-412, 418, 460, 464; Eg98-BOR-871); Tawau Hills Park, 1 minor (GC), SKY, 1996. Sarawak, Malaysia: Bako N. P., 1 major and 1 minor (GC), SKY, 1993; Lambir Hills N. P., 35 majors and 94 minors (GC), SKY, 1993 / 20 majors, 41 minors, 4 queens and 5 males (Eg98-BOR-803, 808, 817, 818, 819, 825, 829); Niah N. P., 3 minors (GC), SKY, 1993. Brunei: Belalong Forest Section, 3 majors and 3 minors (Eg99-BOR-211); Merimbun Heritage Park, 35 majors, 55 minors, 6 queens and 2 males (Eg99-BOR-007, 008, 028, 030, 035, 070, 074, 123, 150, 503, 552, 556, 567, 568). E. Kalimantan, Indonesia: Bt. Soehart (UNMUL forest), 3 minors (GC), SKY, 1992; Kutai N. P., 54 majors and 145 minors (GC), SKY, 1993. INDOCHINA. Thailand: Doi Ang Khang HQ, Chiang Mai Prov., 1300 m alt., 4 majors and 4 minors (TH98-SKY-28); Doi Chiang Dao, nr. Chiang Mai, 500-600 m alt., 1 major and 2 minors (TH98-SKY-18); Doi Suthep, nr. Chiang Mai, ca 600 m alt., 3 majors and 5 minors (TH98-SKY-04) / ca. 800 m alt., 2 majors and 5 minors (TH98-SKY-08); Khao Yai

N. P., Nakhonratchasima, 3 major and 3 minor (TH00-SKY-24). Vietnam: Ba Vi N. P., Ha Tai Prov., 400-800 m alt., 4 majors and 4 minors (Eg99-VN-119); Tam Dao, Vinh Phuc Prov., 800-900 m alt., 10 majors and 10 minors (Eg99-VN-037, 038) / ca. 900 m alt., 17 majors and 17 minors (Eg99-VN-001, 005, 008, 009) / 900-1100 m alt., 3 majors and 5 minors (Eg99-VN-052) / ca. 1100 m alt., 2 majors and 4 minors (VN98-SKY-14). MYEIK'S ARCHIPELAGO, Myanmar. Cat & Kitten I., 1 major, Ecoswiss coll., 1999 (MZLS). MALAY PENINSULA. Thailand: Soi Khao, Pattani Prov., 2 majors and 2 minors (TH98-SKY-40). Malaysia: Ulu Gombak, 2 majors and 3 minors (FI92MG-174, 383). SUMATRA, Indonesia. Sukarami, nr. Padang, W. Sumatra, 5 majors and 5 minors (FI92-66, 83, 162) / 1 major and 2 minors (9/29c), MK, 1999. KRAKATAU IS., Indonesia. P. Anak Krakatau, 1 minor, KUKE; P. Rakata Besar, 4 majors and 26 minors, KUKE; P. Rakata Kecil, 4 minors, KUKE. JAVA, Indonesia. Cibodas, W. Java, 3 majors and 11 minors, KUKE / 3 majors, 5 minors and 2 queens (D28), MK, 1997; Jasinga, nr. Bogor, 1 major and 18 minors (GC), SKY, 1985; Kebun Raya, Bogor, 5 minors (FI95-534, 784) / 2 majors and 2 minors (GC), SKY, 1997 / 7 majors and 18 minors (154, 9/26a, 10/5b, 10/5c), MK, 1998-1999; G. Halimun, 1 major and 3 minors (FI98-373) / 1 major and 2 minors (5/6a), MK, 1998; Pangandaran, W. Java, 1 major and 2 minors (FI95-705). BALI, Indonesia. Kebun Raya, 2 minors (FI94-137).

Major Measurements and indices (n=8): TL 3.9-4.4 mm, HL 1.61-1.89 mm, HW 1.52-1.78 mm, SL 0.89-1.13 mm, FL 1.34-1.58 mm, CI 93-99, SI 56-63, FI 83-91. Head broadest at 5/9-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 34A); head in profile not or only slightly impressed on vertex (Fig. 34B). Hypostoma with an indistinct median process (Fig. 34C). Clypeus with a weak median longitudinal carina, with anterior margin emarginate medially. Eye situated just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.6-1.9 times as long as maximal diameter of eye. Frontal carina weak, extending backward to about 2/3 distance of head. Antennal scrobe inconspicuous, running along frontal carina. Antenna with 3-segmented club; scape reaching 2/3-3/4 distance of head; terminal segment 0.8-0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a low prominence on its posterior declivity (Fig. 34D); the prominence in anterior view not concave medially. Mesopleuron sometimes with a weak transverse impression. Propodeal spine horn-like, sometimes downcurved, 2.5-3 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.5-1.7 times as long as postpetiole (excluding helcium); petiolar node in posterior view slightly emarginate at apex. Postpetiole 1.7-1.9 times as broad as petiolar node.

Frons longitudinally rugose, with interspaces weakly punctured and weakly shining; the longitudinal rugulae curving on occipital lobe; rugulae running almost transversely on posteriormost part of dorsum of occipital lobe (Fig. 34A); antennal scrobe weakly punctured and weakly shining; area between antennal scrobe and subocular level reticulate, with enclosures punctured weakly and dull; lateral face of head with oblique rugulae running from dorsal face of occipital lobe toward anteroventral face of cranium; promesonotal dome in dorsal view transversely rugose, with smooth and shining interspaces; mesopleuron and lateral face of propodeum rugoso-reticulate, with punctured and dull enclosures; petiole (excluding its smooth and shining anterodorsal face) and postpetiole weakly punctured and weakly shining; first gastral tergite around its articulation with postpetiole sometimes weakly punctured and weakly shining; remainder of gaster smooth and shining. Outer face of mandible covered with relatively long decumbent hairs, which are 0.10-0.18 mm in length and much longer than distance between piligerous punctures. Body brown, reddish-brown, dark brown or dark reddish-brown.

Minor Measurements and indices (n=8): TL 2.6-3.1 mm, HL 0.76-0.87 mm, HW 0.63-0.75 mm,

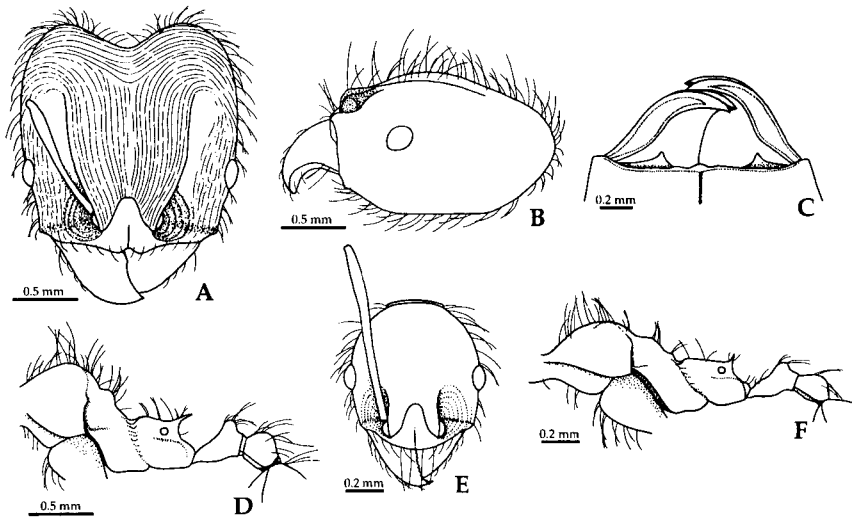

Fig. 34. ***Pheidole plagiaria*** **Fr. Smith (Eg96-BOR-363): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.**

SL 0.93-1.13 mm, AL 1.14-1.32 mm, FL 1.05-1.31 mm, CI 83-87, SI 140-160, FI 158-178. Head in full-face view oval (Fig. 34E); occipital carina well developed. Clypeus sometimes with an inconspicuous median longitudinal carina, with anterior margin in full-face view weakly convex medially. Eyes situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 2/5 length; terminal segment 0.8-0.9 times as long as preceding two segments together. Promesonotal dome with a low prominence on its posterior declivity (Fig. 34F). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, directing relatively upward, 2.5 times as long as diameter of propodeal spiracle. Petiole in profile elongate cuneiform, 1.5-1.6 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not or slightly emarginate at apex. Postpetiole 1.5-1.8 times as broad as petiolar node.

Gena and area between antennal insertion and eye longitudinally rugose; clypeus weakly and irregularly rugose and weakly shining; remainder of head smooth and shining, or very weakly punctured dorsally; promesonotum smooth and shining, or in dorsal view concentrically rugose, with a median area which is smooth and shining or very weakly punctured; mesopleuron and propodeum rugoso-reticulate, with punctured enclosures; lateral faces of petiole and postpetiole very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Body brown to dark brown; flagella and tarsi light brown.

Recognition This relatively large-sized species with a general habitus is recognised among morphologically similar Bornean species by the characters given in the key.

Distribution Indochina, Palawan, Malay Peninsula, Borneo, Sumatra, Krakataus, Java, Bali, Sulawesi and Batjan (Fig. 56).

Bionomics This species inhabits well-developed forests in lowlands and hill areas in Borneo.

However, judging from the presence of this species in forest edges and even in open lands in Tam Dao, N. Vietnam, a habitat shift appears to have occurred in peripheral populations of this wide-ranging species. Yamane (2001, pers. com.) found similar cases for the "Tam Dao population" of widespread *Aenictus dentatus* Forel, and possibly for *Recurvidris* sp. of which the supposed closest relative, *R. browni* Bolton, is thought to be endemic to lowland rainforests in Borneo.

34. *Pheidole planidorsum* sp. nov. (Fig. 35)

Holotype Major, colony: Eg96-BOR-090, near Kota Kinabalu, Sabah, E. Malaysia, K. Eguchi leg., 1996, deposited in UMS.

Paratypes 2 majors, 34 minors and 1 queen from the same colony with the holotype, deposited in BMNH and UMS.

Major Measurements and indices (n=6): TL 2.3 mm, HL 0.85-0.86 mm, HW 0.76 mm, SL 0.40 mm, FL 0.53-0.55 mm, CI 88-90, SI 52-53, FI 70-73. Head broadest at about 3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 35A), in profile slightly impressed on vertex (Fig. 35B). Hypostoma bearing three median processes (medianmost one poorly developed) (Fig. 35C). Clypeus without a median longitudinal carina, with anterior margin very weakly concave medially. Eye situated just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.5 times as long as maximal diameter of eye. Frontal carina weak, extending backward to about 2/3 distance of head. Antennal scrobe inconspicuous, running along frontal carina. Antenna with 3-segmented club; scape extending backward to 3/5 distance of head; terminal segment ca. 1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity (Fig. 35D); each dorsolateral portion of the dome produced outward. Mesopleuron with a weak transverse impression. Propodeal spine elongate-triangular, 2-2.5 times as long as diameter of propodeal spiracle. Petiole 1.6-1.7 times as long as postpetiole (excluding helcium); petiolar node in posterior view weakly emarginate at apex. Postpetiole ca. 1.5 times as broad as petiolar node.

Frons and gena longitudinally rugose; dorsal and dorsolateral faces of occipital lobe reticulate; dorsum of promesonotal dome smooth and shining with several transverse rugulae; lateral face of promesonotal dome smooth and shining; upper part of mesopleuron and lateral face of propodeum punctured weakly and dull; lower part of mesopleuron sometimes partly smooth and shining; lateral faces of petiolar pedicel and postpetiole very weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with appressed to decumbent hairs, which are 0.02-0.04 mm in length and shorter than distance between piligerous punctures. Body yellowish-brown; flagella and tarsi light yellowish-brown.

Minor Measurements and indices (n=5): TL 1.3-1.4 mm, HL 0.44-0.45 mm, HW 0.40-0.41 mm, SL 0.38 mm, AL 0.56-0.58 mm, FL 0.38-0.40 mm, CI 89-92, SI 92-95, FI 95-98. Head in full-face view almost flat posteriorly (Fig. 35E); occipital carina almost absent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye almost as long as maximal diameter of eye. Frontal carina rarely present as an

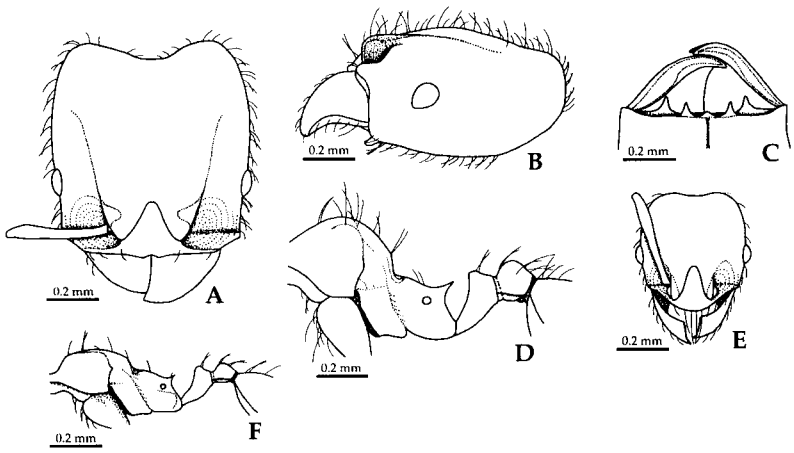

Fig. 35. ***Pheidole planidorsum*** **sp. nov. (type material: Eg96-BOR-090): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.**

inconspicuous rugula extending behind eye. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape slightly extending beyond posterior border of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotal dome low and relatively flat dorsally (Fig. 35F), very weakly margined dorsolaterally, without any prominence on its posterior declivity. Mesopleuron without a distinct transverse impression. Propodeal spine almost twice as long as diameter of propodeal spiracle. Petiole ca. 1.7 times as long as postpetiole (excluding helcium). Postpetiole ca. 1.5 times as broad as petiolar node.

Clypeus smooth and shining; remainder of dorsum of head above subocular level slightly and coarsely rugose and weakly shining; promesonotum largely smooth and shining; remainder of alitrunk punctured; lateral face of petiolar pedicel weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body light yellowish-brown; legs lighter than alitrunk.

Recognition This species, together with *P. merimbun* sp. nov., has a combination of the characteristics noted under *P. merimbun* sp. nov., but occipital lobe is smooth and shining in the major of the latter. This species is also similar to *P. bugi*, but head above subocular level and alitrunk are distinctly punctured in the minor of the latter.

Distribution Borneo.

35. *Pheidole plinii* Forel (Fig. 36)

Pheidole plinii Forel, 1911a: 40, major, minor and queen (MHNG). Type locality: SINGAPORE. Lectotype designation and redescription of type material: Eguchi, 2001.

Specimens examined BORNEO. Sarawak, Malaysia: Mulu (lowland), 1 minor (GC), SKY, 1993. Brunei: Merimbun Heritage Park, 5 majors, 8 minors and 2 queens (Eg99-BOR-047, 055).

Major Measurements and indices (n=6): TL 2.5-3.2 mm, HL 1.12-1.29 mm, HW 1.11-1.23 mm, SL 0.69-0.73 mm, FL 0.84-0.93 mm, CI 95-99, SI 58-63, FI 74-79. Head broadest at 1/2-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and

posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 36A), in profile not impressed on vertex (Fig. 36B). Hypostoma with three low median processes, of which medianmost one is occasionally inconspicuous (Fig. 36C). Clypeus sometimes with a weak median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.3-1.5 times as long as maximal diameter of eye. Frontal carina weak, extending backward to 3/5-2/3 distance of head. Antennal scrobe inconspicuous, running along frontal carina. Antenna with 3-segmented club; scape slightly passing 2/3 distance of head; terminal segment ca. 0.9 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a small denticle in front of basal angle. Promesonotal dome with a distinct prominence on its posterior declivity (Fig. 36D); the prominence in anterior view well concave medially. Mesopleuron without a transverse impression. Propodeal spine ca. 3-3.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.0-1.1 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, 2.2-2.3 times as broad as petiolar node.

Frons and lateral face of head longitudinally rugose; occipital lobe largely smooth and shining; promesonotum largely smooth and shining, and with several transverse rugulae dorsally; mesopleuron, and lateral faces of propodeum and petiole weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Outer face of mandible sparsely covered with decumbent hairs, which are 0.06-0.09 mm in length and a little longer than distance between piligerous punctures. Body yellowish-brown; legs a little lighter than alitrunk.

Minor Measurements and indices (n=7): TL 1.9-2.2 mm, HL 0.60-0.63 mm, HW 0.51-0.53 mm, SL 0.75-0.78 mm, AL 0.85-0.90 mm, FL 0.78-0.82 mm, CI 83-86, SI 145-152, FI 152-157. Head in full-face view oval (Fig. 36E); occipital carina well developed. Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate medially. Eyes situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by a little more than its 1/3 length; terminal segment 0.8-0.9 times as long as preceding two segments together. Promesonotal dome with a pair of low tubercles, with a distinct prominence on its posterior declivity (Fig. 36F). Mesopleuron without a transverse impression. Propodeal spine elongate-triangular, ca. 2.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.1-1.2 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole 2.0-2.2 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; mesopleuron and propodeum punctured; lateral face of petiolar pedicel weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body light brown with a little lighter alitrunk; legs a little lighter than alitrunk.

Recognition This species is characterised by a combination of the following conditions: occipital lobe of the major smooth and shining; posterior declivity of promesonotal dome having a distinct prominence in both the subcastes (Fig. 36D, F); the prominence in anterior view well concave medially in the major; promesonotal dome of the minor having a pair of low tubercles (Fig. 36F);

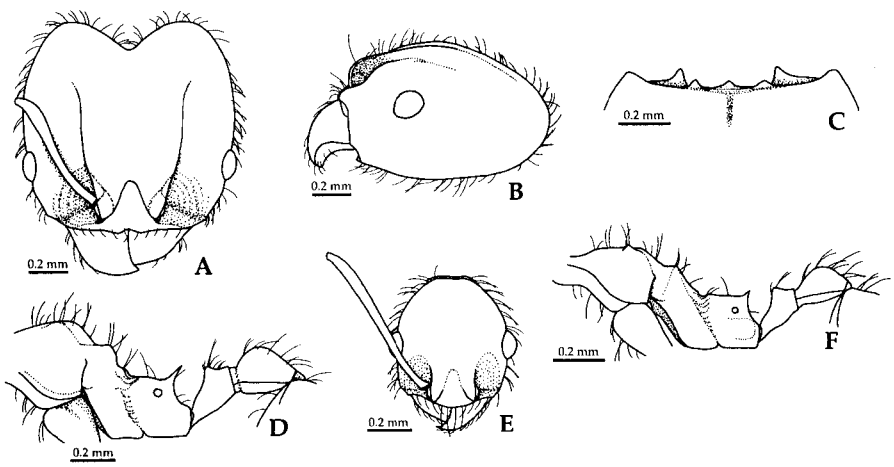

Fig. 36. ***Pheidole plinii*** **Forel (Eg99-BOR-055): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.**

head and promesonotum of the minor smooth and shining.

Distribution Singapore and Borneo.

Bionomics This species seems to inhabit well-developed lowland forests.

36. *Pheidole poringensis* sp. nov. (Fig. 37)

Holotype Major, colony: 6X2906-8-Ea, Poring (ca. 600 m alt.), Sabah, E. Malaysia (Borneo), T. Kikuta leg., 1996, deposited in UMS.

Paratypes 1 major, 4 minors and 1 queen from the same colony to which the holotype belongs, deposited in BMNH and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 1 minor, CB, 1998-1999; Poring, 560 m alt. (East Ridge), 1 minor (code AW-2), CB, 1995 / ca. 600 m alt., 3 majors and 3 minors (6X1010-13-Ab, 6XI0106-13-Ab), TK.

Major Measurements and indices (n=5): TL 2.6-2.8 mm, HL 1.30-1.37 mm, HW 1.18-1.22 mm, SL 0.60-0.61 mm, FL 0.72-0.75 mm, CI 88-91, SI 50-51, FI 61-62. Head broadest at around its midlength (Fig. 37A); head in profile not impressed on vertex (Fig. 37B). Hypostoma bearing three median processes, of which medianmost one is very low and lateral two are large and stout. Clypeus without a median longitudinal carina, with anterior margin weakly concave medially. Eye situated just in front of 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye 2.0-2.1 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape reaching about midlength of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotum forming a high dome, with an inconspicuous prominence on its posterior declivity (Fig. 37C); each dorsolateral portion of the dome weakly produced outward. Mesopleuron with a transverse impression (sometimes inconspicuous). Propodeal spine horn-like,

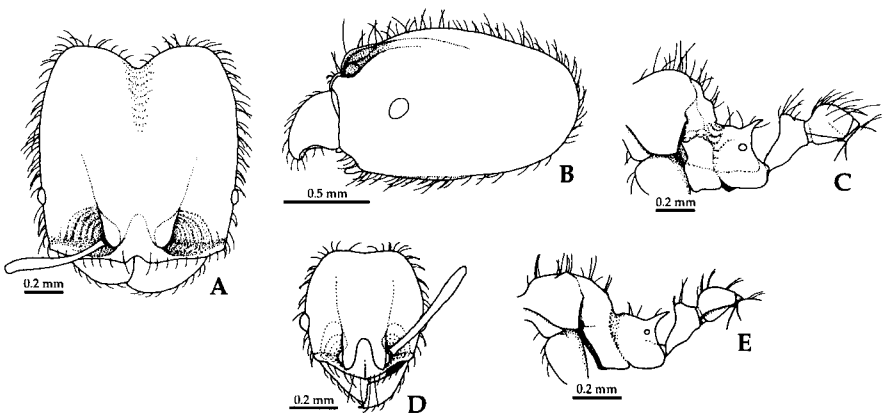

Fig. 37. *Pheidole poringensis* sp. nov. (type material: 6X2906-8-Ea): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

slightly curved, 4-5 times as long as diameter of propodeal spiracle. Petiole 1.3-1.4 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole 2.1-2.2 times as broad as petiolar node.

Frons and gena longitudinally rugose; vertex rugoso-reticulate; dorsal and lateral faces of occipital lobe reticulate; alitrunk reticulate; petiole (excluding its smooth and shining anterodorsal face) and lateral face of postpetiole punctured; dorsum of postpetiole, and gaster smooth and shining. Outer face of mandible covered with decumbent hairs, which are 0.06-0.10 mm in length and longer than distance between piligerous punctures (Fig. 37A). Body brown with lighter waist and gaster; antennae and legs a little lighter than alitrunk.

Minor Measurements and indices (n=5): TL 1.5-1.6 mm, HL 0.54-0.56 mm, HW 0.51-0.52 mm, SL 0.50-0.51 mm, AL 0.70-0.73 mm, FL 0.52-0.55 mm, CI 93-95, SI 96-98, FI 102-106. Head in full-face view slightly concave posteriorly (Fig. 37D); occipital carina evanescent dorsally on head. Clypeus with a weak median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye ca. 1.1 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by its 1/7 length; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotal dome with a pair of low tubercles, with an inconspicuous prominence on its posterior declivity (Fig. 37E). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, ca. 4.5 times as long as diameter of propodeal spiracle. Petiole 1.3-1.4 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole in dorsal view subhexagonal, 1.8-1.9 times as broad as petiolar node.

Clypeus smooth and shining; remainder of dorsal and lateral faces of head reticulate, with smooth and shining enclosures; dorsal face of promesonotum reticulate, with very weakly punctured enclosures; remainder of alitrunk punctured and dull; lateral face of petiolar pedicel weakly punctured; petiolar node, postpetiole and gaster smooth and shining. Body yellowish-brown with a

little lighter waist and gaster; antennae and legs a little lighter than alitrunk.

Recognition This species, together with *P. gombakensis* sp. nov., is very similar to *P. rabo* Forel and *P. tsailuni* Wheeler among Indo-Chinese and Indo-Malayan congeners, but in the latter two mandible is sparsely covered with very short appressed hairs in the major, and head including clypeus is punctured in the minor. The closest relative of this species is probably *P. gombakensis*, but in the latter petiole is almost twice as long as postpetiole in both the subcastes (Fig. 18D, F), and promesonotum is smooth and shining in the minor.

Distribution Borneo.

Bionomics This species seems to inhabits well-developed forests.

37. *Pheidole quadrensis* Forel (Fig. 38)

Pheidole quadrensis Forel, 1900: 25, major (MHNG). Type locality: Kajactonam, Sumatra. One syntype (major) was examined.

P. (*Pheidolacanthinus*) *quadrensis*: Forel, 1913: 45.

Pheidole quadrensis: Bolton, 1995b: 328.

Specimens examined BORNEO. Sabah, Malaysia: Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Gunong Rara, 7 majors and 18 minors (Eg96-BOR-328; Eg97-BOR-535, 542, 571); Mahua Waterfall area, 10 majors, 10 minors and 10 males (Eg00-BOR-129); Poring, 450-500 m alt., 2 majors and 4 minors (Eg96-BOR-279) / ca. 500-600 m alt., 1 minor (GC), SKY, 1995 / ca. 600 m alt., 1 major and 3 minors (06Q36B5), TK / ca. 900 m alt., 1 major, 10 minors and 2 queens (512A; 6XI2810-2-Da, 7IV0510-7-1a), TK / 1360 m alt. (East Ridge), 1 minor (code DB-1), CB, 1995; Sepilok forest, 6 majors, 12 minors and 2 queens (Eg97-BOR-471; Eg98-BOR-870, 876); Tawau Hills Park, 1 major, 4 minors, 1 queen and 2 males (Eg96-BOR-034) / 1 minor (GC), SKY, 1996. Sarawak, Malaysia: Bako N. P., 1 major and 1 minor (FI96-535); Bt. Entimau (390 m alt.), 3 minors (GC), Mahmud leg., 1994; Kubah N. P., 1 minor (GC), SKY, 1993; Lambir Hills N. P., 5 majors, 13 minors and 2 queens (Eg98-BOR-806, 822). Brunei: Belalong Forest Section, 3 majors and 2 minors (Eg99-BOR-217); Merimbun Heritage Park, 6 majors and 7 minors (Eg99-BOR-052, 535). E. Kalimantan, Indonesia: Kutai N. P., 3 minors (GC), SKY, 1993 / 1 minor (Pit fall trap), T. Yajima leg., 1986. SUMATRA, Indonesia: Lubuk Gadang (W. Sumatra), 6 minors, SNS; Ulu Gadut, Padang, W. Sumatra, 3 majors and 6 minors (FI97-440, 499); Limau Manis, Padang, W. Sumatra, 1 major, 2 minors and 1 queen (FI92-10); Sitiung, W. Sumatra, 1 major and 2 minors (FI93-255).

Major Measurements and indices (n=10): TL 4.1-5.1 mm, HL 1.83-2.07 mm, HW 1.90-2.28 mm, SL 0.99-1.08 mm, FL 1.32-1.47 mm, CI 103-110, SI 47-53, FI 64-71. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head weakly emarginate medially (Fig. 38A); head in profile not impressed on vertex (Fig. 38B). Hypostoma with a pair of stout median processes (Fig. 38C). Clypeus with a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.8-2.1 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to about 2/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape reaching about 3/5-2/3 distance of head; terminal segment 0.9-1.1 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a pair of spines (Fig. 38D, E), with a prominence on its posterior declivity (Fig. 38E); the prominence in anterior view weakly or very weakly concave medially. Mesopleuron with an inconspicuous transverse impression. Propodeal spine pointed apically, with broad base, 5-6 times as

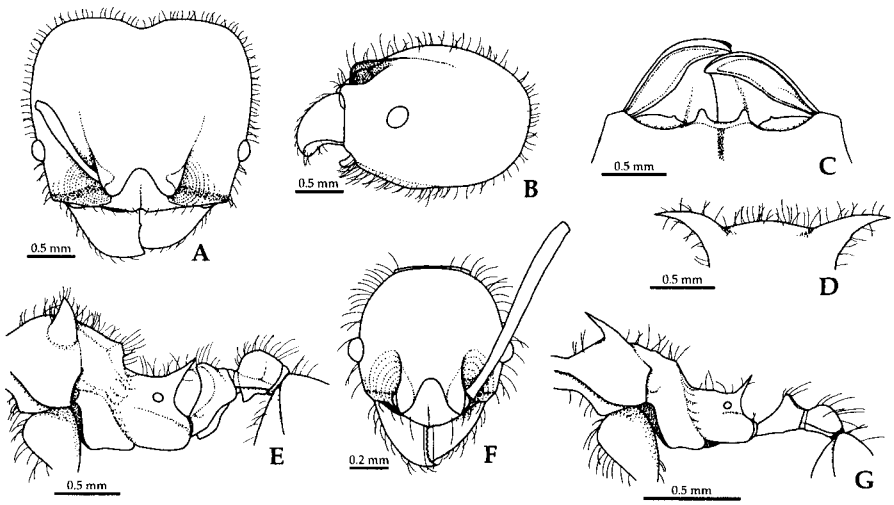

Fig. 38. ***Pheidole quadrensis*** **Forel (Eg98-BOR-806): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, promesonotum in anterior veiw; E, same, alitrunk and waist in profile; F, minor, head in full-face view; G, same, alitrunk and waist in profile.**

long as diameter of propodeal spiracle (Fig. 38E). Petiole cuneiform, 1.5-1.7 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex; subpetiolar process low, truncate anteriorly. Postpetiole 1.8-2.1 times as broad as petiolar node.

Frons and gena longitudinally rugose, with smooth and shining interspaces; occipital lobe reticulate, with smooth and shining enclosures; alitrunk irregularly rugoso-reticulate; petiole smooth and shining anterodorsally, weakly rugose and weakly shining posterodorsally, and punctured and dull laterally; postpetiole largely punctured, or punctured and dull laterally and transversely rugose dorsally; dorsum of gaster and anterior part of first gastral sternite distinctly punctured and dull. Outer face of mandible sparsely covered with decumbent or suberect hairs, which are 0.08-0.11 mm in length and almost as long as, or a little longer than, distance between piligerous punctures. Body reddish-brown to dark reddish-brown; antennae and legs a little lighter than alitrunk.

Minor Measurements and indices (n=13): TL 2.4-2.9 mm, HL 0.75-0.89 mm, HW 0.67-0.78 mm, SL 0.90-1.14 mm, AL 1.00-1.20 mm, FL 0.96-1.15 mm, CI 83-91, SI 131-148, FI 138-155. Head in full-face view oval (Fig. 38F), with distinct occipital carina. Clypeus with a median longitudinal carina, with anterior margin in full-face view weakly convex medially. Eyes situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 1.0-1.1 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.9-1.0 times as long as preceding two segments together. Promesonotal dome with a pair of spines, with an inconspicuous prominence on its posterior declivity (Fig. 38G). Mesopleuron without a transverse impression. Propodeal spine horn-like, sometimes slightly recurved, 4-5 times as long as diameter of propodeal spiracle (Fig. 38G). Petiole in profile cuneiform, ca. 1.4 times as long as postpetiole (excluding helcium); petiolar node in posterior

view not emarginate at apex; its posterior face usually margined dorsally and laterally. Postpetiole 1.8-2.2 times as broad as petiolar node.

Clypeus smooth and shining with several rugulae, or very weakly rugose and weakly shining; remainder of head reticulate; alitrunk largely reticulate, but area between promesonotal spines smooth and shining; lateral faces of petiole and postpetiole weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Body sparsely bearing standing hairs. Body brown, reddish-brown or dark brown; antennae and legs a little lighter than alitrunk.

Recognition *P. quadrensis* is closely related to *P. lokitae* Forel, *P. quadricuspis* Emery, *P. sperata* Forel, *P. acantha* sp. nov. and *P. spinicornis* sp. nov., and several undescribed species, and they are recognisable among Indo-Chinese and Indo-Malayan congeners by a combination of the characteristics noted under *P. lokitae*. They are, according to Emery (1921), related to Austro-Malayan "*P. quadrispinosa* Fr. Smith group" and "*P. cervicornis* Emery group". *P. quadrensis* is well distinguished form the Bornean relatives by the characters given in the key.

Distribution Borneo and Sumatra.

Bionomics This species inhabits well-developed forests in lowlands. It nests in rotting twigs and wood blocks on the forest floor, and stores up a number of tiny seeds in its nest (Eg97-BOR-471, 535). I have never encountered colonies which include more than one dealate queen.

38. *Pheidole quadricuspis* Emery (Figs. 39, 61)

Pheidole quadricuspis Emery, 1900: 683, major and minor (MCSN). Type locality: Sumatra. Three syntypes (1 major and 2 minors) were examined.

P. (Pheidolacanthinus) quadricuspis: Emery, 1921: 83.

Pheidole quadricuspis: Bolton, 1995b: 328.

Specimens examined BORNEO. Sabah, Malaysia: Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Gunong Rara, 28 majors, 49 minors and 3 queens (Eg96-BOR-315, 319, 320, 343A, 343B, 353, 370, 372; Eg97-BOR-530, 557, 558); Poring, 800 m alt. (East Ridge), 1 minor (code BW-1), CB, 1995; Sepilok forest, 1 major and 1 minor (Eg97-BOR-495). Brunei: Belalong Forest Section, 2 majors, 5 minors and 1 queen (Eg99-BOR-222); Merimbun Heritage Park, 13 majors, 18 minors, 7 queens and 24 males (Eg99-BOR-039, 111, 112, 522, 585). E. Kalimantan, Indonesia: Kutai N. P., 3 majors and 3 minors (GC), SKY, 1993. MALAY PENINSULA. Malaysia: Ulu Gombak, 11 majors, 27 minors and 2 queens (FI96- 604, 605; FI98-113, 114, 130, 188, 197). SUMATRA, Indonesia: Lubuk Gadang, W. Sumatra, 2 majors and 11 minors, SNS.

Major Measurements and indices (n=10): TL 4.1-5.1 mm, HL 1.83-2.07 mm, HW 1.90-2.28 mm, SL 0.99-1.08 mm, FL 1.32-1.47 mm, CI 103-110, SI 47-53, FI 71-64. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head in full-face view almost flat, but slightly emarginate medially (Fig. 39A); head in profile not impressed on vertex (Fig. 39B). Hypostoma with a pair of stout median processes. Clypeus with a median longitudinal carina, with anterior margin in full-face view emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.7-2.0 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to about midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about 2/3-3/4 distance of head; terminal segment 0.9-1.0 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and

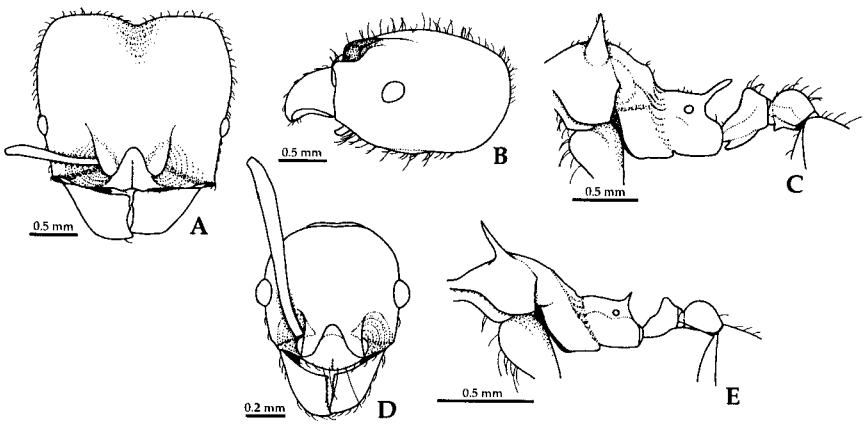

Fig. 39. ***Pheidole quadricuspis*** **Emery (Eg96-BOR-319): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

a denticle in front of basal angle. Promesonotal dome with a pair of spines, with a low or inconspicuous prominence on its posterior declivity (Fig. 39C); the prominence in anterior view not or very weakly concave medially. Mesopleuron with a transverse impression. Propodeal spine digitiform, with narrow base, weakly down-curved, 5-6 times as long as diameter of propodeal spiracle (Fig. 39C). Petiole cuneiform, 1.3-1.4 times as long as postpetiole (excluding helcium); petiolar node in posterior view emarginate at apex; subpetiolar process low; its anteroventral corner bluntly produced forward. Postpetiole 1.5-1.8 times as broad as petiolar node.

Frons and gena longitudinally rugose, with smooth and shining interspaces; occipital lobe reticulate, with smooth and shining enclosures; alitrunk irregularly rugoso-reticulate; petiole smooth and shining anterodorsally, rugose posterodorsally, and punctured laterally; postpetiole largely punctured, or punctured and dull laterally and transversely rugose dorsally; first gastral tergite rugose finely or punctured, and dull. Outer face of mandible sparsely covered with appressed hairs, which are 0.07-0.11 mm in length and shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs; alitrunk bearing a few very short standing hairs. Body reddish-brown to dark reddish-brown, with a little darker gaster; flagella and legs a little lighter than alitrunk.

Minor Measurements and indices (n=5): TL 2.4-2.5 mm, HL 0.77-0.80 mm, HW 0.69-0.75 mm, SL 0.91-0.98 mm, AL 1.01-1.12 mm, FL 0.98-1.07 mm, CI 88-94, SI 130-138, FI 140-146. Head in full-face view oval; occipital carina distinct (Fig. 39D). Clypeus with a weak median longitudinal carina, with anterior margin in full-face view weakly convex medially. Eyes situated at or behind midlength of head; distance between mandibular insertion and anterior margin of head 0.9-1.1 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.9-1.0 times as long as preceding two segments together. Promesonotal dome with a pair of spines, without a prominence on its posterior declivity (Fig. 39E). Mesopleuron without a transverse impression. Propodeal spine elongate-triangular, 1.5 times as long

as diameter of propodeal spiracle. Petiole cuneiform, 1.1-1.2 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole 2.0-2.2 times as broad as petiolar node.

Head including clypeus smooth and shining; promesonotum smooth and shining dorsally, and weakly punctured laterally; mesopleuron and propodeum punctured; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Head with a few standing hairs (Fig. 39D); alitrunk lacking standing hairs (Fig. 39E); petiole, postpetiole and gaster very sparsely scattered with standing hairs. Body brown to dark brown (sometimes alitrunk is a little lighter than head and gaster).

Variation Two completely allopatric forms that differ in length and density of hairs on alitrunk of the major are recognised in the material examined. The minors of these two forms have no conspicuous standing hairs on alitrunk, and cannot be separated from each other. All majors from Borneo cited above uniformly bear a few very short standing hairs, while those from the southern Malay Peninsula and W. Sumatra bear longer standing hairs more densely (unfortunately my previous examination of the type material (Sumatra) did not focus on this character of the major). Further examinations of additional specimens from various localities (especially within Sumatra) and reexamination of the major in the type material are required in order to conclude their status (I tentatively treat them as conspecific). Moreover, minors which are similar to those of *P. quadricuspis* except in its hairy body have been collected from Kutai N. P., E. Kalimantan (4 minors, SKY, 1993) and Maninjau, W. Sumatra (5 minors, SNS). However, I omit them from the enumeration of specimens, because I have never examined majors coupled with the hairy minors and this did not allow me to conclude their status.

Recognition *P. quadricuspis* is most closely related to *P. lokitae* Forel, *P. quadrensis* Forel, *P. sperata* Forel, *P. acantha* sp. nov. and *P. spinicornis* sp. nov., and several undescribed species (see under *P. lokitae*), but can be distinguished form the Bornean relatives by the characters given in the key.

Distribution Southern Malay Peninsula, Borneo and Sumatra (Figs. 61).

Bionomics This species inhabits well-developed forests in lowlands. It nests in rotting twigs and wood blocks on the forest floor, and stores up a number of tiny seeds in its nest (Eg99-BOR-111). I have never encountered colonies which included more than one dealate queen. This species is sympatric with *P. quadrensis* in Deramakot, Gunong Rara, Poring and Sepilok, Sabah, and Belalong and Merimbun, Brunei; and also sympatric with *P. spinicornis* sp. nov. in Sepilok.

39. *Pheidole quinata* Eguchi (Figs. 40, 58)

Pheidole quinata Eguchi, 2000, major and minor (UMS (holotype), MCSN, MCZ, MHNG, MNHA, NHMW). Type locality: Sayap Kinabalu (ca. 1000 m alt.), Sabah, Borneo.

Specimens examined SUMATRA, Indonesia. Ulu Gadut, Padang, W. Sumatra, 6 minors, SNS. JAVA, Indonesia. Cibodas, W. Java, 2 minors, KUKE; Juanda Park (ca. 880 m alt.), Bandung, W. Java, 1 major and 5 minors (FI96-221).

Major Measurements and indices (n=1): TL 5.0 mm, HL 2.40 mm, HW 2.24 mm, SL 1.24 mm, FL 1.91 mm, CI 93; SI 55, FI 85. Head in full-face view broadest just behind midlength of head (Fig. 40A); head in profile impressed on vertex (Fig. 40B). Hypostoma with three median processes, of which medianmost one is inconspicuous. Clypeus with a median longitudinal carina, with anterior

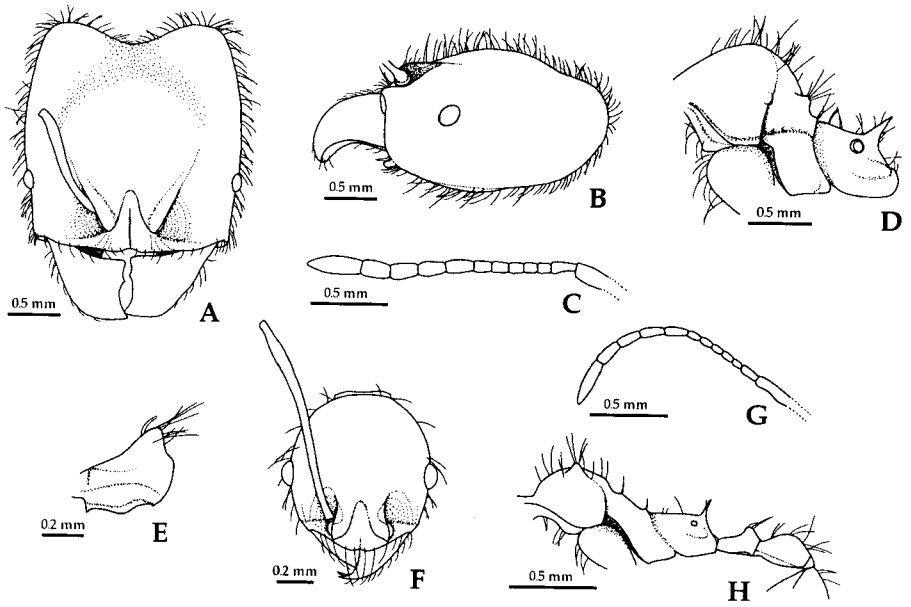

Fig. 40. ***Pheidole quinata*** **Eguchi: A, major, head in full-face view; B, same, head in profile; C, same, flagellum of antenna; D, same, alitrunk in profile; E, same, petiole in profile; F, minor, head in full-face view; G, same, flagellum of antenna; H, same, alitrunk and waist in profile. Partly modified from Eguchi (2000).**

margin shallowly emarginate. Eye situated at 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye ca. 2.2 times as long as maximal diameter of eye. Frontal carina very weak, just reaching 1/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 5-segmented club (Fig. 40C); scape reaching 3/5 distance of head. Masticatory margin of head with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a small prominence on its posterior declivity; the prominence in anterior view not concave medially; each dorsolateral portion of the dome weakly produced outward (Fig. 40D). Mesopleuron weakly divided by a transverse impression into upper and lower parts. Propodeal spine horn-like, straight, ca. 3 times as long as diameter of propodeal spiracle. Petiole cuneiform, almost as long as postpetiole, bearing a low subpetiolar process (Fig. 40E); petiolar node in posterior view emarginate at apex. Postpetiole in dorsal view subpentagonal, ca. 2.2 times as broad as petiolar node.

Frons longitudinally rugose; vertex, occipital lobe and lateral face of head rugoso-reticulate, with very weakly punctured enclosures; promesonotum with transverse but irregular rugulae; mesopleuron partially smooth and shining; propodeum rugose except for its smooth declivitous face; petiole smooth and shining dorsally, finely punctured laterally and ventrally; postpetiole and the anterior part of first gastral segment finely punctured. Outer face of mandible sparsely covered with decumbent hairs, which are 0.13-0.26 mm in length and longer than distance between piligerous punctures. Body dark brown; flagella and legs brown.

Minor Measurements and indices (n=16): TL 2.5-2.7 mm, HL 0.78-0.84 mm, HW 0.70-0.75 mm,

SL 1.06-1.13 mm, AL 1.15-1.23 mm, FL 1.16-1.25 mm, CI 86-89, SI 147-154, FI 164-168. Head in full-face view oval (Fig. 40F); occipital carina well developed. Clypeus with a weak median longitudinal carina, with anterior margin weakly emarginate medially. Eye situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 1.1-1.2 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 5-segmented club (Fig. 40G); in full-face view scape well extending beyond posterior margin of head by more than its 1/3 length. Promesonotum forming a relatively high dome, with a pair of low tubercles, with a prominence on its posterior declivity. Mesopleuron without a transverse impression. Metanotal groove shallow and indistinct (Fig. 40H). Propodeal spine horn-like, slender, directed dorsally, at most 5 times as long as diameter of propodeal spiracle. Petiole in profile cuneiform, 0.8-0.9 times as long as postpetiole; petiolar node in posterior view not emarginate at apex. Postpetiole longer than broad, almost twice as broad as petiole, in profile hemispherical, convex dorsally and slightly convex ventrally.

Clypeus smooth and shining, sometimes with a few rugulae; remainder of head almost smooth and shining; promesonotum smooth and shining; remainder of alitrunk distinctly punctured; petiole (excluding weakly punctured lateral face) smooth and shining; postpetiole and gaster almost smooth and shining over the surface. In profile dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing approximately 20 standing hairs; remainder of dorsum of alitrunk bearing approximately 10 standing hairs (Fig. 40H). Head and alitrunk brown to dark brown; petiole, postpetiole, gaster, flagellar segments and legs lighter than alitrunk.

Recognition This species and *P. sabahna* Eguchi are peculiar in having antenna of both the subcastes with 5-segmented club, and are well distinguished from each other by the characters given in the key.

Distribution Borneo, Sumatra and Java (Fig. 58).

Bionomics This species seems to inhabit hill forests.

40. *Pheidole rabo* Forel (Fig. 41)

Pheidole rabo Forel, 1913: 28, major, minor and queen (MHNG). Type locality: Sumatra. Lectotype designation and redescription of type material: Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia: Gunong Rara, 1 major and 3 minors (Eg97-BOR-588). MALAY PENINSULA. Malaysia: Ulu Gombak, 10 majors and 21 minors (FI92MG-111, 203, 468, 511, 576, 577); Kota Tingi, 1 major and 2 minors (FI92MKT-5).

Major Measurements and indices (n=1): TL 2.8 mm, HL 1.51 mm, HW 1.42 mm, SL 0.62 mm, FL 0.85 mm, CI 94, SI 44, FI 60. Head broadest around its midlength; posterior margin of head in full-face view emarginate triangularly (Fig. 41A), in profile weakly impressed on vertex (Fig. 41B). Hypostoma bearing three median processes, of which lateral two are larger (Fig. 41C). Clypeus with an evanescent median longitudinal carina, with anterior margin weakly concave medially. Eye situated at about 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye almost twice as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about midlength of head; terminal segment almost as long as

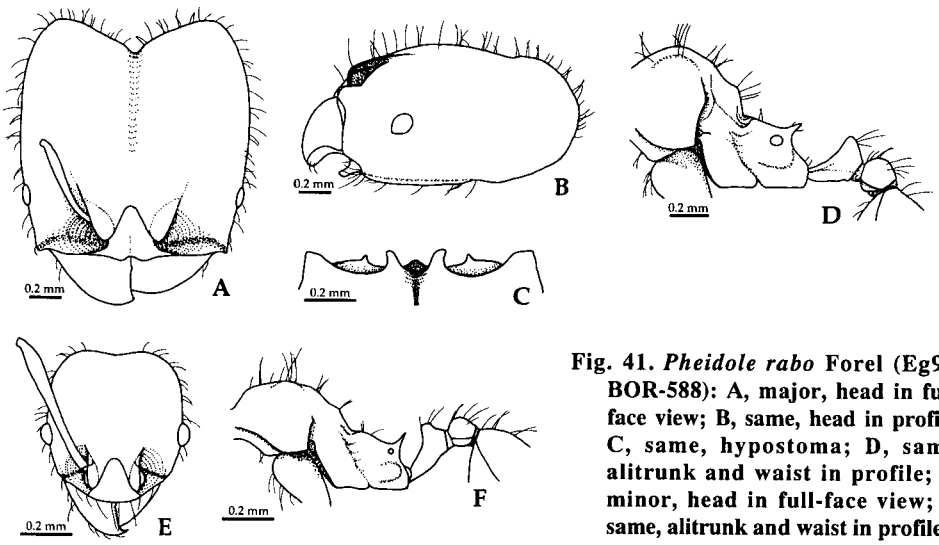

Fig. 41. *Pheidole rabo* Forel (Eg97-BOR-588): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.

preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a distinct denticle in front of basal angle. Promesonotum forming a high dome, with an inconspicuous prominence on its posterior declivity (Fig. 41D); each dorsolateral portion of the dome somewhat angularly produced outward. Mesopleuron without a distinct transverse impression. Propodeal spine digitiform, ca. 2.5 times as long as diameter of propodeal spiracle. Petiole ca. 1.7 times as long as postpetiole (excluding helcium); petiolar node high, in posterior view slightly emarginate at apex. Postpetiole ca. 1.7 times as broad as petiolar node, angulate laterally.

Frons longitudinally rugose, with smooth and shining interspaces; dorsal and dorsolateral faces of occipital lobe reticulate, with smooth and shining enclosures; lateral face of head rugoso-reticulate with enclosures weakly punctured and weakly shining; dorsum of promesonotum irregularly rugose, with enclosures punctured and weakly shining; lower part of mesopleuron and declivitous face of propodeum smooth and shining partly; remainder of alitrunk, and petiole and postpetiole punctured and dull; first gastral tergite punctured and dull. Outer face of mandible sparsely covered with very short appressed hairs (≤ 0.03 mm in length), which are much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body yellowish-brown with a little lighter gaster; antennae and legs lighter than alitrunk.

Minor Measurements and indices (n=2): TL 1.7-1.9 mm, HL 0.60 mm, HW 0.53 mm, SL 0.53-0.54 mm, AL 0.79-0.81 mm, FL 0.59-0.61 mm, CI 89, SI 100-101, FI 111-115. Head in full-face view slightly concave posteriorly (Fig. 41E); occipital carina evanescent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of the midlength of head; distance between mandibular insertion and anterior margin of eye 1.1-1.2 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club in full-face view; scape extending beyond posterior border of head by its 1/7 length; terminal segment ca. 1.1 times as long as preceding two segments together. Promesonotum forming a relatively low dome, with a pair of low tubercles, and with an inconspicuous prominence on its posterior declivity (Fig. 41F). Mesopleuron

without a transverse impression. Propodeal spine slender and pointed, ca. 3.5 times as long as diameter of propodeal spiracle. Petiole ca. 1.9 times as long as postpetiole (excluding helcium) with long pedicel (almost as long as postpetiole); petiolar node conspicuous, in posterior view not emarginate at apex. Postpetiole 1.4-1.5 times as broad as petiolar node.

Clypeus slightly rugose, with punctured and dull interspaces; most part of dorsum of head excluding clypeus and dorsum of promesonotum weakly reticulate, with punctured enclosures; lateral faces of head and alitrunk, and petiole and postpetiole punctured and dull; first gastral tergite very weakly and finely rugoso-reticulate just around its articulation with postpetiole. Body light yellowish-brown with a little lighter gaster; antennae and legs lighter than alitrunk.

Recognition This species may be closely related to *P. tsailuni* Wheeler among Indo-Chinese and Indo-Malayan congeners, but I refrain from concluding the relationship between them until additional specimens from various localities, especially southern part of Thailand, are available. This species is similar to *P. bugi*, but in the latter eye of the major larger, three processes on hypostoma of head of the major subequal in size, anterolateral face of head below subocular level smooth and shining in the minor.

Distribution Southern Malay Peninsula, Borneo and Sumatra.

Bionomics This species seems to inhabit well-developed lowland forests.

41. *Pheidole retivertex* sp. nov. (Fig. 42)

Holotype Major, colony: Eg98-BOR-865, Sepilok forest, Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1998, deposited in UMS.

Paratypes 5 majors, 12 minors, 2 queens and 1 male from the same colony to which the holotype belongs, deposited in BMNH, MCZ, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Gunong Rara, 2 majors and 5 minors (Eg97-BOR-578); Poring, 560 m alt. (East Ridge), 1 minor (code AW-2/9), CB, 1995 / 600 m alt., 3 majors, 6 minors and 1 male (6XI0106-14-4; 06Q37S5, 06Q46S5), TK; Sepilok forest, 25 majors, 49 minors, 5 queens and 3 males (Eg97-BOR-411, 411B, 411C, 433, 477, 496, 497, 498; Eg98-BOR-875). MALAY PENINSULA. Malaysia: Ulu Gombak, 3 majors and 5 minors (FI92MG-188). SUMATRA, Indonesia. Ulu Gadut, Padang, W. Sumatra, 1 major, 2 minors and 1 queen (FI97-341).

Major Measurements and indices (n=5): TL 2.5-2.8 mm, HL 1.34-1.54 mm, HW 1.20-1.39 mm, SL 0.62-0.70 mm, FL 0.73-0.82 mm, CI 89-92, SI 48-52, FI 58-61. Head with almost parallel sides (Fig. 42A); head in profile not impressed on vertex (Fig. 42B). Hypostoma with a large median process. Clypeus with a median longitudinal carina, with anterior margin concave medially. Eye situated at about 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye 1.7-2.0 times as long as maximal diameter of eye. Frontal carina well developed, horizontal, extending backward to 2/3 distance of head (Fig. 42A). Antennal scrobe overhung by frontal carina. Antenna with 3-segmented club; scape extending backward to about 3/5 distance of head; terminal segment ca. 1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a small or inconspicuous prominence on its posterior declivity (Fig. 42C); each dorsolateral portion of the dome weakly produced outward. Mesopleuron

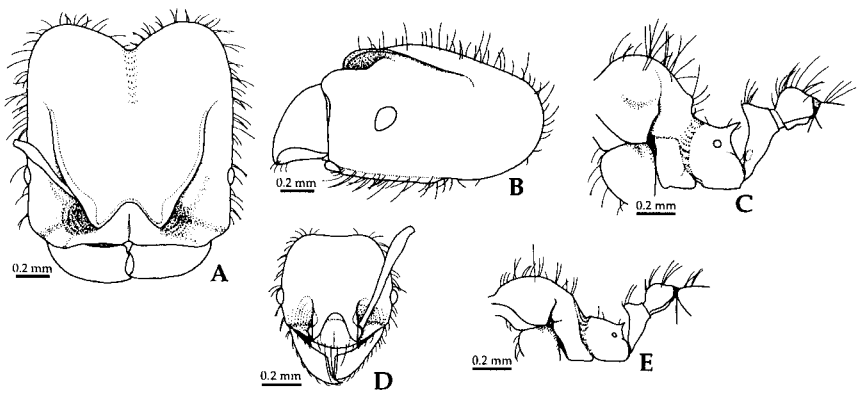

Fig. 42. ***Pheidole retivertex*** **sp. nov. (type material: Eg98-BOR-865): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

with an inconspicuous transverse impression. Propodeal spine straight and acute, 2.5-3 times as long as diameter of propodeal spiracle. Petiole 1.6-1.7 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole 2.0-2.2 times as broad as petiolar node, in dorsal view angulate laterally.

Frons and gena longitudinally rugose; vertex, and dorsal and lateral faces of occipital lobe reticulate, with enclosures smooth and shining or very weakly punctured; promesonotum weakly reticulate with smooth and shining enclosures dorsally, and very weakly punctured or puncto-rugose laterally; upper part of mesopleuron irregularly reticulate; lower part of mesopleuron smooth and shining; lateral face of propodeum weakly punctured, or smooth and shining; lateral faces of petiole and postpetiole punctured weakly and dull; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with very short appressed hairs (≤ 0.02 mm in length), which are much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Head and alitrunk brown to reddish-brown, with darker clypeus; waist, gaster, antennae and legs yellowish-brown or light brown.

Minor Measurements and indices (n=5): TL 1.9-2.0 mm, HL 0.58-0.62 mm, HW 0.57-0.60 mm, SL 0.56-0.61 mm, AL 0.83-0.91 mm, FL 0.61-0.66 mm, CI 97-98, SI 96-103, FI 104-112. Head in full-face view at most very weakly concave posteriorly (Fig. 42D); occipital carina very weak dorsally on head. Clypeus with a median longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eyes situated at about midlength of head; distance between mandibular insertion and anterior margin of eye 0.8-1.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 1/6 length; terminal segment ca. 1.1 times as long as preceding two segments together. Promesonotal dome without a distinct prominence on its posterior declivity (Fig. 42E). Mesopleuron without a transverse impression. Propodeal spine triangular, 1.5-2.0 times as long as diameter of propodeal spiracle. Petiole 1.4-1.5 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole in dorsal view subhexagonal, ca. 1.9 times as broad as petiole.

Clypeus almost smooth and shining; remainder of dorsum of head weakly rugoso-reticulate, with enclosures very weakly punctured; lateral face of head weakly reticulate; dorsum of promesonotum very weakly punctured, or almost smooth with several irregular rugulae; lateral face of promesonotum weakly punctured; remainder of alitrunk largely punctured and dull; lateral face of petiolar pedicel weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Head and alitrunk light brown; waist, gaster, antennae and legs yellowish-brown.

Recognition *P. retivertex* sp. nov is closely related to *P. nodgii* Forel, *P. magrettii* Emery, *P. tjibodana* Forel, *P. sayapensis* sp. nov. and several undescribed species, and all these are peculiar among Indo-Chinese and Indo-Malayan congeners in having the combination of the characteristics noted under *P. tjibodana*. This species is most closely related to *P. magrettii*, but in the latter head and alitrunk of the minor are distinctly punctured. This species is also easily distinguished from two Bornean relatives, *P. tjibodana* and *P. sayapensis* sp. nov., by the characters given in the key.

Distribution Southern Malay Peninsula, Borneo and Sumatra.

Bionomics This species inhabits well-developed lowland forests, and nests in rotting wood blocks and twigs, and stores up a number of tiny seeds in its nest (Eg97-BOR-411). I have never encountered colonies which include more than one dealate queen.

42. *Pheidole rugifera* sp. nov. (Fig. 43)

Holotype Major, colony: Eg98-BOR-836, Lambir Hills N. P., near Miri, Sarawak, E. Malaysia (Borneo), K. Eguchi leg., 1998, deposited in FRCK.

Paratypes 19 majors and 20 minors from the same colony to which the holotype belongs, deposited in BMNH, FRCK, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sarawak, Malaysia: Kubah N. P., 1 minor (GC), SKY, 1994; Lambir Hills N. P., 8 majors and 9 minors (Eg98-BOR-802, 813) / 8 minors (GC), SKY, 1993 and 1995. MALAY PENINSULA. Malaysia: Ulu Gombak, 1 major and 1 minor (FI92MG-470). SUMATRA, Indonesia. Maninjau, W. Sumatra, 1 minor, SNS.

Major Measurements and indices (n=6): TL 1.9-2.2 mm, HL 0.84-0.94 mm, HW 0.77-0.84 mm, SL 0.38-0.40 mm, FL 0.46-0.49 mm, CI 89-92, SI 45-52, FI 55-63. Head broadest at about 1/2-3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 43A), in profile weakly impressed on vertex (Fig. 43B). Hypostoma bearing one median process (rarely this process reduced in size). Clypeus without a median longitudinal carina, with anterior margin weakly concave medially; lateral part of clypeus weakly produced dorsally, but not developed into a horn as seen in *P. clypeocornis* sp. nov. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.7 times as long as maximal diameter of eye. Frontal carina horizontal, extending backward to 3/5-2/3 distance of head (Fig. 43A). Antennal scrobe narrowly overhung by frontal carina. Antenna with 3-segmented club; scape extending backward to 1/2-3/5 distance of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and two denticles in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity (Fig. 43C); each dorsolateral portion of the dome produced outward. Mesopleuron divided by a weak transverse impression into upper and lower parts. Propodeal spine triangular or elongate-triangular, almost twice as long as diameter of propodeal spiracle. Petiole 1.8-1.9 times as long as postpetiole (excluding

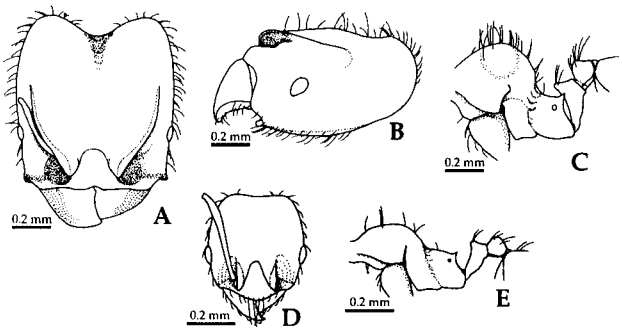

Fig. 43. *Pheidole rugifera* sp. nov. (type material: Eg98-BOR-836): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

helcium); petiolar node in posterior view not or slightly emarginate at apex. Postpetiole 1.5-1.8 times as broad as petiolar node.

Dorsum of head excluding occipital lobe longitudinally rugose, with interspaces punctured very weakly and shining; dorsal and dorsolateral faces of occipital lobe reticulate, with enclosures punctured very weakly and shining; outer face of mandible with rugulae running from mandibular base toward masticatory margin (Fig. 43A); dorsum of promesonotal dome weakly reticulate, with weakly punctured enclosures; lateral face of promesonotum weakly punctured or rugose; lower part of mesopleuron and declivitous face of propodeum largely smooth and shining; remainder of alitrunk largely punctured; ventral faces of midcoxa and hindcoxa distinctly reticulate; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Outer face of mandible sparsely covered with very short appressed hairs (≤ 0.02 mm in length), which are much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body light brown to brown; antennae and legs lighter than alitrunk.

Minor Measurements and indices (n=6): TL 1.3-1.4 mm, HL 0.42-0.44 mm, HW 0.38-0.41 mm, SL 0.35-0.37 mm, AL 0.52-0.55 mm, FL 0.36-0.39 mm, CI 90-94, SI 90-94, FI 96-93. Head in full-face view weakly concave posteriorly (Fig. 43D); occipital carina absent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.8-0.9 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape slightly extending beyond posterior border of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotal dome without a prominence on its posterior declivity (Fig. 43E). Mesopleuron without a distinct transverse impression. Propodeal spine ca. 1.5 times as long as diameter of propodeal spiracle. Petiole 1.8-2.0 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole in dorsal view, 1.5-1.6 times as broad as petiolar node.

Dorsum of head above subocular level including clypeus punctured; ventral face below subocular level smooth and shining; alitrunk punctured; lateral face of petiolar pedicel weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body brown with a little lighter gaster; antennae and legs lighter than alitrunk.

Recognition *P. rugifera* sp. nov. is closely related to *P. maculifrons* Wheeler (known only from the Philippines), *P. tenebricosa* sp. nov., *P. clypeocornis* sp. nov., *P. kikutai* sp. nov. and *P. hortensis* Forel, and all these are recognised among congeners by the characteristics noted under *P. hortensis*. Among the species known from Borneo, only *P. rugifera* sp. nov. and *P. tenebricosa* sp. nov. have punctured head and alitrunk in the minor. The major of the former is distinguishable from that of the latter in which mandible is rugose only around its base.

Distribution Southern Malay Peninsula, Borneo and Sumatra.

Bionomics This species inhabits well-developed lowland forests, and nests in rotting wood.

43. *Pheidole sabahna* Eguchi (Figs. 44, 58)

Pheidole sabahna Eguchi, 2000: 688-691, major, minor and male (UMS, MCSN, MCZ, MHNG, MNHA, NHMW). Type locality: Logging area nr. Kg. Yoshina, Ranau, Sabah, E. Malaysia (Borneo).

Specimens examined BORNEO. Sabah, Malaysia: Deramakot Forest Reserve, 1 minor, CB, 1998-1999; Logging area nr. Kg. Yoshina, 3 majors and 7 minors (Eg98-BOR-855); Logging area nr. Ranau, 3 majors and 8 minors (Eg98-BOR-839); Poring, 550 m alt. (East Ridge), 2 minors, Kern leg., 1995 / ca. 550-600 m alt., 1 minor (GC), SKY, 1995 / 650 m alt., 1 minor (bait No. 632), E. Aug leg., 1994. Sarawak, Malaysia: G. Gading N. P., 1 minor (GC), Abd. Rahman Nona leg., 1994; Kubah N. P., 1 minor (GC), SKY, 1993; Lambir Hills N. P., 1 minor (GC), HO, 1995; Mulu (lowland), 2 minors (GC), SKY, 1993; Ng. Lelap, Lobang Baya, 1 minor (GC), K. Het leg., 1994; Semangoh N. P., 2 minors (GC), SKY, 1993; Sg. Segerugok, Song, 1 major and 1 minor (GC), Abd. Rahman Nona leg., 1993.

Major Measurements and indices (n=15): TL 5.5-5.9 mm, HL 2.25-2.62 mm, HW 2.12-2.48 mm, SL 1.33-1.42 mm, FL 1.98-2.17 mm, CI 90-96, SI 56-63, FI 86-94. Head in full-face view broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 44A); head in profile not impressed on vertex (Fig. 44B). Hypostoma with three low median processes. Clypeus with a median longitudinal carina medially, with anterior margin weakly emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.9-2.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 5-segmented club (Fig. 44C); scape reaching about 2/3 distance of head. Promesonotal dome with a small prominence on its posterior declivity (Fig. 44D); the prominence in anterior view very weakly concave medially. Mesopleuron weakly divided by a transverse impression into upper and lower parts. Metanotal groove weak. Propodeal spine horn-like, straight, ca. 4 times as long as diameter of propodeal spiracle. Petiole in profile cuneiform, 1.1-1.2 times as long as postpetiole, bearing a low subpetiolar process (Fig. 44E); petiolar node in posterior view not, or slightly, emarginate at apex. Postpetiole in dorsal view subpentagonal, 1.8-2.0 times as broad as petiole, in profile strongly convex dorsally and almost flat ventrally.

Frons longitudinally rugose; vertex, occipital lobe and lateral face of head rugoso-reticulate, with enclosures very weakly punctured; alitrunk rugoso-reticulate excluding smooth declivitous face of propodeum; petiole (excluding smooth anterodorsal face) and postpetiole weakly punctured and dull; gaster smooth and shining. Body brown to reddish-brown, with darker gaster; legs a little lighter than alitrunk. Outer face of mandible sparsely covered with long decumbent hairs, which are 0.18-0.24 mm in length and much longer than distance between piligerous punctures.

Minor Measurements and indices (n=36): TL 3.5-3.7 mm, HL 0.88-1.08 mm, HW 0.78-0.93 mm, SL 1.15-1.41 mm, AL 1.30-1.58 mm, FL 1.33-1.69 mm, CI 83-89, SI 121-134, FI 165-193. Head in

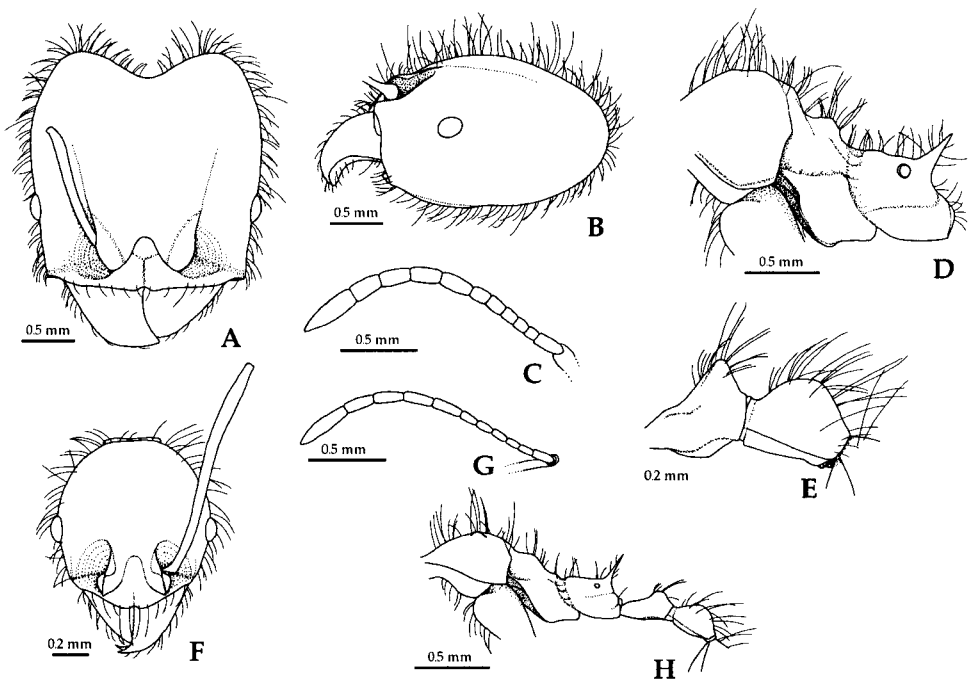

Fig. 44. ***Pheidole sabahna*** **Eguchi: A, major, head in full-face view; B, same, head in profile; C, same, flagellum of antenna; D, same, alitrunk in profile; E, same, waist in profile; F, minor, head in full-face view; G, same, flagellum of antenna; H, same, alitrunk and waist in profile. Partly modified from Eguchi (2000).**

full-face view oval (Fig. 44F); occipital carina well developed. Clypeus with a median longitudinal carina, with anterior margin weakly emarginate medially. Eye situated at or in front of midlength of head; distance between mandibular insertion and anterior margin of eye ca. 1.3 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 5-segmented club (Fig. 44G); in full-face view scape extending well beyond posterior border of head by more than its 1/3 length. Promesonotum forming a relatively low dome, usually with a pair of low tubercles, and with a prominence on its posterior declivity (Fig. 44H). Mesopleuron sometimes with an inconspicuous transverse impression. Metanotal groove relatively deep (Fig. H). Propodeal spine horn-like, slender, directed upward, 6-7 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.0-1.1 times as long as postpetiole; petiolar node in posterior view not emarginate at apex. Postpetiole 2.0-2.2 times as broad as petiolar node.

Head including clypeus and promesonotum almost smooth and shining; remainder of alitrunk punctured distinctly (occasionally smooth and shining dorsally); petiole (excluding weakly punctured lateral face of pedicel) smooth and shining; postpetiole and gaster almost smooth and shining. In profile dorsum of promesonotal dome in front of the prominence on its posterior declivity bearing more than 20 standing hairs, and remainder of dorsum of alitrunk also bearing more than 20 standing hairs (Fig. 44H). Body brown to dark brown.

Recognition This species and *P. quinata* Eguchi are peculiar in having antenna of both the subcastes

with 5-segmented club, and are distinguished from each other by the characters given in the key.

Distribution Borneo (Fig. 58).

Bionomics This species inhabits well-developed lowland or hill forests. I found several colonies nesting in the soil at logging fronts near Ranau, Sabah.

44. *Pheidole sarawakana* Forel (Fig. 45)

Pheidole sauberi subsp. *sarawakana* Forel, 1911a: 45, major and minor (MHNG). Type locality: Sarawak, Borneo.

Pheidole sarawakana: Eguchi, 2001, with lectotype designation and redescription of type material.

Specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 30 majors, 39 minors, 2 queens and 45 males (Eg96-BOR-164, 171, 172, 231, 247) / 1 minor, CB, 1998-1999; Poring, 560 m alt. (East Ridge), 1 minor (code AW-2), CB, 1995 / ca. 600 m alt., 2 majors and 2 minors (23A), TK / 800 m alt. (East Ridge), 1 minor (code BW-1/4), CB, 1995 / ca. 900 m alt., 2 majors, 3 minors and 1 queen (483-A), TK. MALAY PENINSULA. Malaysia: Ulu Gombak, 2 majors and 3 minors (FI92MG-298). SUMATRA, Indonesia. Ulu Gadut, Padang, W. Sumatra, 1 major and 2 minors (FI96-203). JAVA, Indonesia. Kebun Raya, Bogor, 2 majors and 5 minors (10/21a), MK, 1999.

Major Measurements and indices (n=7): TL 1.9-2.2 mm, HL 0.97-1.05 mm, HW 0.88-0.92 mm, SL 0.45-0.49 mm, FL 0.58-0.63 mm, CI 87-91, SI 51-54, FI 64-70. Head broadest at about 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 45A), in profile not impressed on vertex (Fig. 45B). Hypostoma bearing a pair of median processes. Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.8-2.3 times as long as maximal diameter of eye; 4-5 ommatidia present on longest axis of eye. Frontal carina inconspicuous, extending backward to about midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about 3/5 distance of head; terminal segment 1.2-1.3 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a distinct denticle in front of basal angle. Promesonotum forming a high dome (Fig. 45C), in profile without a prominence on its posterior declivity; each dorsolateral portion of the dome not produced outward. Mesopleuron divided by a transverse impression into two parts, of which lower part is distinctly margined dorsally. Propodeal spine elongate-triangular or horn-like, 2-2.5 times as long as diameter of propodeal spiracle. Petiole 1.9-2.0 times as long as postpetiole (excluding helcium); petiolar node high (Fig. 45C), in posterior view not emarginate at apex. Postpetiole high, 1.2-1.4 times as broad as petiolar node.

Dorsum of head excluding occipital lobe longitudinally rugose, with smooth and shining interspaces; occipital lobe smooth and shining (Fig. 45A); promesonotum smooth and shining, sometimes with several transverse rugulae dorsally; remainder of alitrunk largely smooth and shining, or mesopleuron and lateral face of propodeum weakly rugoso-reticulate; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Outer face of mandible sparsely covered with appressed to decumbent hairs, which are 0.08-0.10 mm in length and much longer than distance between piligerous punctures. Head and alitrunk light brown; antennae, legs and gaster lighter than alitrunk.

Minor Measurements and indices (n=7): TL 1.3-1.6 mm, HL 0.48-0.52 mm, HW 0.44-0.48 mm, SL 0.43-0.46 mm, AL 0.61-0.67 mm, FL 0.46-0.50 mm, CI 90-94, SI 95-99, FI 103-108. Head in full-

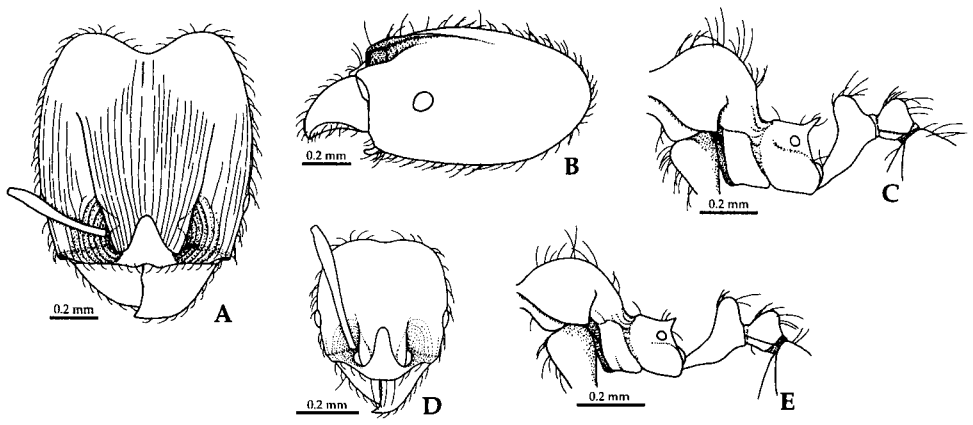

Fig. 45. *Pheidole sarawakana* Forel (23A, TK): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

face view almost straight or slightly concave posteriorly (Fig. 45D); occipital carina almost absent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 1.1-1.2 times as long as maximal diameter of eye; four ommatidia present on longest axis of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 1/6 length; terminal segment 1.2-1.3 times as long as preceding two segments together. Promesonotal dome without a prominence on its posterior declivity (Fig. 45E). Mesopleuron divided by a transverse impression into two parts, of which lower part is distinctly margined dorsally. Propodeal spine triangular, 1.5-2 times as long as diameter of propodeal spiracle. Petiole 1.9-2.0 times as long as postpetiole (excluding helcium); petiolar node high, in posterior view not emarginate at apex. Postpetiole high, 1.2-1.3 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; mesopleuron and lateral face of propodeum weakly punctured at least in part; petiole and postpetiole largely smooth and shining; gaster smooth and shining. Body light yellowish-brown to light brown; antennae and legs sometimes a little lighter than alitrunk.

Recognition *P. sarawakana* is most closely related to *P. elisae* Emery, *P. sauberi* Forel and *P. tandjongensis* Forel (see under *P. elisae*), and is sympatric with *P. elisae* and *P. sauberi* in several localities in Borneo. In *P. sauberi* dorsum of occipital lobe of the major is completely covered with longitudinal rugulae (Fig. 46A), and eye is relatively large (6-7 ommatidia on longest axis of eye in the major, and 5-6 in the minor); and in *P. elisae* eye is also relatively large (8 ommatidia on longest axis of eye in the major, and 6-7 in the minor).

Distribution Southern Malay Peninsula, Borneo, Sumatra and Java.

Bionomics This species inhabits well-developed lowland forests, and nests in rotting wood blocks.

45. *Pheidole sauberi* Forel (Fig. 46)

Pheidole sauberi Forel, 1905: 18, major and minor (MHNG). Type locality: Bogor, Java. Lectotype designation and redescription of type material: Eguchi, 2001.

Specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 4 majors and 9 minors (Eg96-BOR-115, 210); Gunong Rara, 3 majors and 5 minors (Eg97-BOR-572); nr. Kota Kinabalu, 3 majors and 5 minors (Eg96-BOR-102); Mahua Waterfall area, 3 majors and 3 minors (colony A), K. G. Kim leg., 2000; Poring, ca. 500-550 m alt., 3 majors and 5 minors (Eg96-BOR-302) / ca. 600 m alt., 13 majors, 20 minors and 1 male (78-A, 518, 731; 6X3006-10-Ad, 6XII0606-S3-2, 6XII0606-S3-12, 6XII2106-21-Bb, 6XII2106-24-Aa), TK; Sayap Kinabalu, 5 majors, 9 minors and 2 males (Eg96-BOR-046, 069) / 2 majors and 2 minors (SB96-SKY-40); Sepilok forest, 14 majors, 30 minors and 2 queens (Eg97-BOR-415, 425, 452, 485, 487, 502, 513); Tawau Hills Park, 8 majors, 9 minors and 3 males (Eg96-BOR-006, 020) / 1 major and 1 minor (SB96-SKY-06). Sarawak, Malaysia: Lambir Hills N. P., 5 majors (GC), SKY, 1993; Kubah N. P., 1 major (GC), SKY, 1993. E. Kalimantan, Indonesia: Kutai N. P., 2 majors (GC), SKY, 1993. MALAY PENINSULA. Thailand: Khao Chong, Trang Prov., 1 major and 2 minors (TH98-SKY-37). Malaysia: Ulu Gombak, 9 majors, 14 minors and 1 queen (FI92MG-441, 585, 672; FI96-607, 622). LUZON, Philippines. Mt. Makiling, Los Baños, 2 majors and 3 minors (GC, SKY, 1999; PH99-SKY-04). SUMATRA, Indonesia. Sitiung, W. Sumatra, 3 majors and 5 minors (FI93-254, 258). JAVA, Indonesia: Kebun Raya, Bogor, 2 majors and 5 minors (10/4b), MK, 1999; Cibodas, W. Java, 1 major and 1 minor (J1), MK, 1998; G. Halimun, 1 major and 1 minor (5/4d), MK, 1998; Pangandaran, W. Java, 2 majors and 3 minors (FI95-667).

Major Measurements and indices (n=7): TL 2.1-2.7 mm, HL 1.00-1.20 mm, HW 0.91-1.09 mm, SL 0.53-0.61 mm, FL 0.66-0.78 mm, CI 89-91, SI 53-59, FI 68-74. Head broadest at 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 46A), in profile not impressed on vertex (Fig. 46B). Hypostoma bearing a pair of median processes (Fig. 46C). Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.7 times as long as maximal diameter of eye; 6-7 ommatidia present on longest axis of eye. Frontal carina inconspicuous, extending backward to 3/5-2/3 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; antennal scape reaching about 3/5 distance of head; terminal segment 1.1-1.2 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotum forming a high dome, without a prominence on its posterior declivity (Fig. 46D); each dorsolateral portion of the dome not produced outward. Mesopleuron divided by a transverse impression into two parts, of which lower part is distinctly margined dorsally. Propodeal spine horn-like, 2-2.5 times as long as diameter of propodeal spiracle. Petiole 1.8-2.0 times as long as postpetiole (excluding helcium); petiolar node high (Fig. 46D), in posterior view not emarginate at apex. Postpetiole high, 1.4-1.5 times as broad as petiolar node.

Dorsum of head completely covered with longitudinal rugulae (Fig. 46A; sometimes rugoso-reticulate around posterodorsal extremity of occipital lobe); lateral face of occipital lobe smooth and shining, or finely rugoso-punctured and dull; promesonotum smooth and shining, with several transverse rugulae dorsally; remainder of alitrunk smooth and shining, or weakly punctured; lateral faces of petiole and postpetiole weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with decumbent hairs, which are 0.08-0.11 mm in length and much longer than distance between piligerous punctures. Body yellowish-brown, brown, reddish-brown or dark reddish-brown; antennae and legs a little lighter than alitrunk.

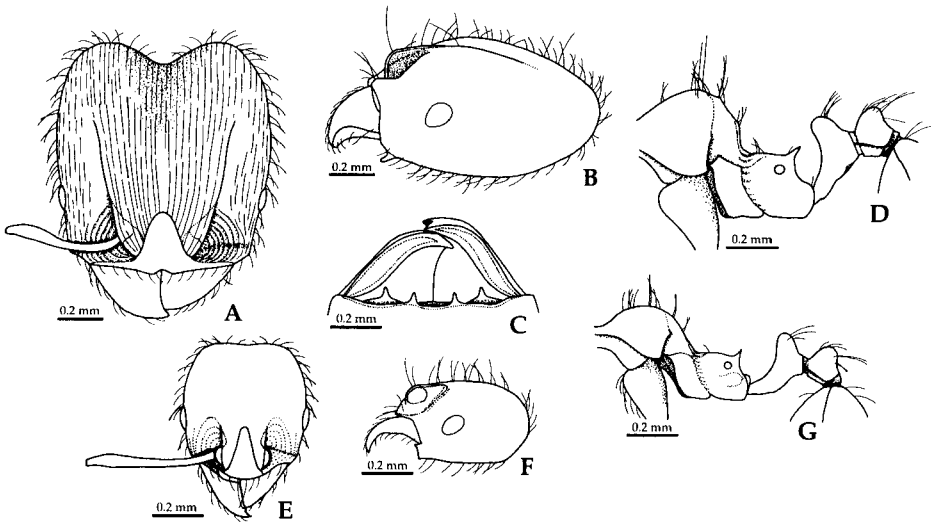

Fig. 46. ***Pheidole sauberi*** **Forel (Eg96-BOR-302): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, head in profile; G, same, alitrunk and waist in profile.**

Minor Measurements and indices (n=7): TL 1.4-1.8 mm, HL 0.48-0.58 mm, HW 0.43-0.51 mm, SL 0.47-0.56 mm, AL 0.63-0.75 mm, FL 0.50-0.61 mm, CI 88-92, SI 102-112, FI 110-120. Head in full-face view almost straight posteriorly (Fig. 46E); occipital carina almost absent dorsally on head. Clypeus without median longitudinal carina, with anterior margin in full-face view slightly convex or truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.8-0.9 times as long as maximal diameter of eye (Fig. 46F); 5-6 ommatidia present on longest axis of eye. Frontal carina sometimes present as an evanescent rugula which extends to 1/2-2/3 distance of head (as measured from anteriormost and posteriormost of head). Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by its 1/4-1/5 length; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotum convex, without any prominence on its posterior declivity (Fig. 46G). Mesopleuron divided by transverse impression into two parts of which lower part is distinctly margined dorsally. Propodeal spine almost twice as long as diameter of propodeal spiracle. Petiole 1.9-2.0 times as long as postpetiole (excluding helcium); petiolar node high (Fig. 46G), in posterior view not emarginate at apex. Postpetiole high, 1.3-1.4 times as broad as petiolar node.

Gena with several rugulae; remainder of head including clypeus, and promesonotum smooth and shining; remainder of alitrunk smooth and shining, or weakly punctured partly; lateral face of petiole inconspicuously punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body light yellowish-brown, light brown, brown or dark brown; flagella and legs a little lighter than alitrunk.

Recognition *P. sauberi* is most closely related to *P. elisae* Emery, *P. sarawakana* Forel and *P.*

tandjongensis Forel (see under *P. elisae*), and is sympatric with *P. elisae* and *P. sarawakana* in several localities. In *P. elisae* and *P. sarawakana* occipital lobe of the major is smooth and shining (Figs. 14A, 45A); and in *P. sarawakana* eye of both the subcastes is relatively small (Fig. 45B).

Distribution Luzon, Malay Peninsula, Borneo, Sumatra and Java.

Bionomics This species inhabits well-developed lowland and hill forests, and usually nests in rotting wood blocks on the ground.

46. *Pheidole sayapensis* sp. nov. (Fig. 47)

Holotype Major, colony: Eg98-BOR-051, Sayap Kinabalu (1000 m alt.), Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1996, deposited in UMS.

Paratypes 3 majors, 15 minors, 1 queen and 1 male from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Sayap Kinabalu, 3 minors (LS-5), SKY, 1996.

Major Measurements and indices (n=3): TL 3.2 mm, HL 1.47-1.57 mm, HW 1.32-1.41 mm, SL 0.71-0.72 mm, FL 0.78-0.82 mm, CI 89-90, SI 51-54, FI 57-59. Head with almost parallel sides; posterior margin of head in full-face view emarginate medially (Fig. 47A); head in profile distinctly convex in posterior part of frons; anterior declivity of the convexity flat, and posterior declivity slightly impressed (Fig. 47B). Hypostoma with a large median process. Clypeus without a median longitudinal carina, with anterior margin weakly emarginate medially. Eye situated at about 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye 2.0-2.3 times as long as maximal diameter of eye. Frontal carina well developed, horizontal, extending backward to 2/3 distance of head (Fig. 47A). Antennal scrobe extensively overhung by frontal carina. Frontal lobe reduced. Antenna with 3-segmented club; scape extending backward to 3/5 distance of head; terminal segment 1.2-1.3 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a low prominence on its posterior declivity (Fig. 47C); the prominence in anterior view not concave medially; each dorsolateral portion of the dome weakly produced outward. Mesopleuron with a weak transverse impression. Propodeal spine horn-like, blunt apically, ca. 5 times as long as diameter of propodeal spiracle. Petiole 1.8-2.0 times as long as postpetiole (excluding helcium); petiolar node distinct, in posterior view slightly emarginate at apex. Postpetiole 1.3-1.5 times as broad as petiole, in dorsal view trapezoidal, in profile right-angled anteroventrally.

Frons longitudinally rugose; vertex, and dorsal and lateral faces of occipital lobe reticulate, with enclosures smooth and shining or very weakly punctured; area between antennal scrobe and eye weakly reticulate, with enclosures punctured and dull; alitrunk largely reticulate, with enclosures smooth and shining; petiole (excluding its smooth and shining anterior face) and postpetiole reticulate; gaster smooth and shining. Outer face of mandible covered with very short appressed hairs (≤ 0.02 mm in length), which are much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of much longer appressed to decumbent hairs. Body dark reddish-brown; flagella and legs lighter than alitrunk.

Minor Measurements and indices (n=5): TL 1.8-2.0 mm, HL 0.65-0.68 mm, HW 0.63-0.65 mm,

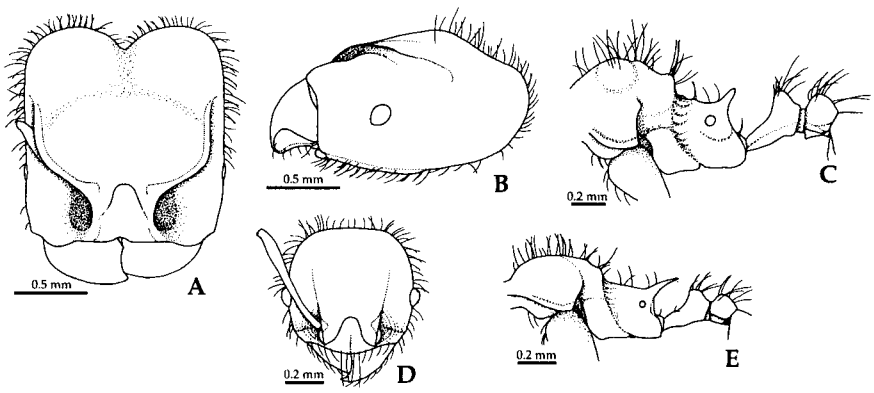

Fig. 47. ***Pheidole sayapensis*** **sp. nov. (type material: Eg98-BOR-051): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

SL 0.55-0.60 mm, AL 0.87-0.90 mm, FL 0.62-0.65 mm, CI 95-98, SI 87-92, FI 97-99. Head in full-face view almost truncate posteriorly (Fig. 47D); occipital carina evanescent dorsally on head. Clypeus with a median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eyes situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 1.1-1.2 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior margin of head by its 1/6 length; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotum forming a low dome; dorsum of the dome relatively flat (Fig. 47E). Mesopleuron without a distinct transverse impression. Propodeal spine horn-like, slightly downcurved, ca. 6 times as long as diameter of propodeal spiracle (Fig. 47E). Petiole 1.9-2.0 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole ca. 1.3 times as broad as petiole.

Clypeus with several irregular rugulae; remainder of head and alitrunk distinctly reticulate; petiole (excluding its anterior face smooth and shining) and postpetiole weakly reticulate; gaster smooth and shining. Body dark brown; flagella and legs lighter than alitrunk.

Recognition *P. sayapensis* sp. nov. is closely related to *P. nodgii* Forel, *P. magrettii* Emery, *P. tjibodana* Forel, *P. retivertex* sp. nov. and several undescribed species, and all these are peculiar among Indo-Chinese and Indo-Malayan congeners in having the combination of the characteristics noted under *P. tjibodana*. *P. sayapensis* sp. nov. is distinguishable form the Bornean relatives in having distinctly reticulate head and alitrunk in the minor, and very long propodeal spine in the minor (Fig. 47E).

Distribution Borneo.

Bionomics This species has so far been collected from only Sayap Kinabalu (ca. 1000 alt.). This species seems to inhabit well-developed hill forests. The colony Eg96-BOR-051 nested in a rotting wood block, and stored up a number of tiny seeds inside the nest.

47. *Pheidole spinicornis* sp. nov. (Fig. 48)

Holotype Major, colony: Eg98-BOR-880, Sepilok forest, Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1998, deposited in UMS.

Paratypes 8 majors and 12 minors from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 1 minor, CB, 1998-1999; Poring, ca. 500 m alt., 1 minor (Sample R-46), H. Hirosawa leg., 1997 / 560 m alt. (East Ridge), 1 minor (code AW-3), CB, 1995 / ca. 600 m alt., 3 minors (6X2906), TK / 600-700 m alt., 7 minors (GC), SKY, 1995; Sayap, 1 major and 2 minors (Honey bait sample: HD-91), KE, 1996. Sarawak, Malaysia: Lambir Hills N. P., 1 minor (GC), SKY, 1993.

Major Measurements and indices (n=5): TL 4.1-4.9 mm, HL 1.62-2.03 mm, HW 1.73-2.12 mm, SL 0.98-1.13 mm, FL 1.37-1.57 mm, CI 104-107, SI 54-59, FI 74-81. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head in full-face view flat, with a small emargination medially (Fig. 48A); head in profile not impressed on vertex (Fig. 48B). Hypostoma with a pair of stout median processes. Clypeus with a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.6-1.8 times as long as maximal diameter of eye. Frontal carina inconspicuous, extending backward to about midlength of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about 2/3 distance of head; terminal segment almost as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a pair of spines which slightly or weakly curve backward; posterior declivity of the dome with a distinct prominence (Fig. 48C); the prominence in anterior view weakly concave medially. Mesopleuron with an inconspicuous transverse impression. Propodeal spine horn-like, weakly downcurved, 7-8 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.5-1.6 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex; subpetiolar process very low, or almost absent. Postpetiole ca. 1.8-2.0 times as broad as petiolar node, in dorsal view angulate laterally, in profile right-angled anteroventrally.

Frons and gena longitudinally rugose; vertex, and dorsal and lateral faces of occipital lobe reticulate; alitrunk irregularly rugoso-reticulate; petiole (excluding its smooth and shining anteroventral face) punctured; postpetiole punctured, or punctured laterally and transversally rugose dorsally; dorsum of gaster punctured and dull. Outer face of mandible covered with decumbent hairs, which are 0.10-0.19 mm in length and longer than distance between piligerous punctures. Body (except in relatively teneral individuals) dark reddish-brown with lighter alitrunk

Minor Measurements and indices (n=6): TL 2.7-3.0 mm, HL 0.74-0.90 mm, HW 0.68-0.83 mm, SL 0.93-1.13 mm, AL 1.05-1.24 mm, FL 1.01-1.25 mm, CI 89-95, SI 127-139, FI 139-153. Head in full-face view oval (Fig. 48D), with distinct occipital carina. Clypeus with a weak median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eyes situated at or behind midlength of head; distance between mandibular insertion and anterior margin of eye 1.0-1.2 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior margin of head by more than its 1/3 length; terminal segment ca. 0.9 times as long as preceding two segments together.

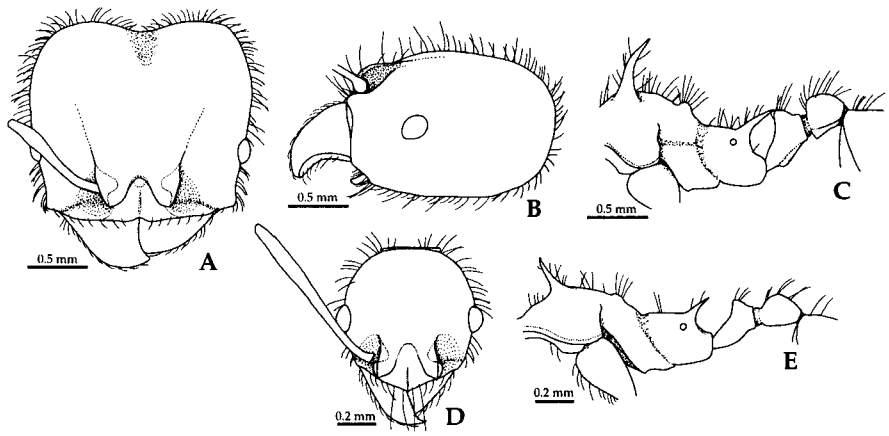

Fig. 48. ***Pheidole spinicornis*** **sp. nov. (type material: Eg98-BOR-880): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

Promesonotal dome with a pair of spines dorsolaterally, with an inconspicuous prominence on its posterior declivity (Fig. 48E). Mesopleuron without a transverse impression. Propodeal spine horn-like, weakly downcurved, ca. 5 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.3 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole 1.9-2.2 times as broad as petiolar node.

Clypeus smooth and shining, sometimes with several rugulae; remainder of head smooth and shining dorsally and punctured laterally; alitrunk largely punctured and dull, but area between promesonotal spines occasionally smooth and shining; lateral faces of petiole and postpetiole weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Body brown to reddish-brown, with darker gaster; antennae and legs a little lighter than alitrunk.

Variation Head and alitrunk of minors from Poring is weakly rugoso-reticulate with punctured and dull enclosures.

Recognition *P. spinicornis* sp. nov. is closely related to *P. lokitae* Forel, *P. quadrensis* Forel, *P. sperata* Forel, *P. quadricuspis* Emery and *P. acantha* sp. nov., and several undescribed species (see under *P. lokitae*), but can be recognised among the five Bornean species by the characters given in the key.

Distribution Borneo.

Bionomics This species seems to inhabit well-developed forests in lowlands and hill areas. It is completely sympatric with two of its supposed relatives, *P. quadricuspis* Emery and *P. quadrensis* Forel, in Sepilok forest.

48. *Pheidole submonticola* sp. nov. (Fig. 49)

Holotype Major, colony: 243A, Mt. Kinabalu (near the Headquarters, ca. 1500 m alt.), Sabah, E. Malaysia (Borneo), T. Kikuta leg., 1997, deposited in UMS.

Paratypes 7 minors from the same colony to which the holotype belongs, deposited in BMNH, MCZ,

NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Poring, ca. 900 m alt., 1 minor (6B), TK.

Major Measurements and indices (n=1): TL 4.4 mm, HL 2.00 mm, HW 1.90 mm, SL 1.00 mm, FL 1.46 mm, CI 95, SI 53, FI 77. Head broadest at 3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); posterior margin of head in full-face view strongly emarginate (Fig. 49A); head in profile gently impressed on vertex (Fig. 49B). Hypostoma without any median process. Clypeus with a median longitudinal carina, with anterior margin emarginate medially. Eye situated in front of 1/3 distance of head; distance between mandibular insertion and anterior margin of eye ca. 1.7 times as long as maximal diameter of eye. Frontal carina weak, extending backward to almost 3/5 distance of head. Antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending backward to about 3/5 distance of head; terminal segment 0.9 times as long as preceding two segments together. Mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a very small prominence on its posterior declivity (Fig. 49C); the prominence in anterior view not concave medially; promesonotal suture (sensu Bolton, 1994) present dorsolaterally as a shallow impression. Mesopleuron divided by a transverse impression into two parts, of which lower part is margined dorsally. Propodeal spine horn-like, broadly based (Fig. 49C), ca. 3.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.2 times as long as postpetiole (excluding helcium); petiolar node apically acute in profile, and weakly emarginate at apex in posterior view. Postpetiole in dorsal view angulate laterally, 2.5 times as broad as petiolar node.

Frons longitudinally rugose, with smooth and shining interspaces; the longitudinal rugulae curving outward on occipital lobe, and interspaces smooth and shining; lateral face of head below subocular level largely rugose longitudinally, but smooth and shining medially; anterior and lateral face of promesonotal dome and lower part of mesopleuron smooth and shining; remainder of alitrunk irregularly and coarsely rugose, with enclosures smooth and shining; lateral faces of petiole and postpetiole very weakly punctured; dorsum of petiole smooth and shining; dorsum of postpetiole almost smooth and shining with several transverse rugulae; anterior part of first gastral tergite around its articulation with postpetiole finely rugose longitudinally. Outer face of mandible sparsely covered with very short appressed hairs, which are 0.03-0.06 mm in length and much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body reddish-brown; antennae and legs lighter than alitrunk.

Minor Measurements and indices (n=8): TL 2.3-2.7 mm, HL 0.69-0.80 mm, HW 0.57-0.65 mm, SL 0.92-1.01 mm, AL 1.04-1.18 mm, FL 1.04-1.16 mm, CI 82-87, SI 155-161, FI 178-182. Head in full-face view oval (Fig. 49D); occipital carina well developed Clypeus with an inconspicuous median longitudinal carina only apically, with anterior margin in full-face view truncate medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye ca. 0.9 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by more than its 1/3 length; terminal segment 0.8-0.9 times as long as preceding two segments together. Promesonotal dome with a pair of indistinct tubercles, without a prominence on its posterior declivity (Fig. 49E). Mesopleuron without a transverse impression. Propodeal spine elongate-

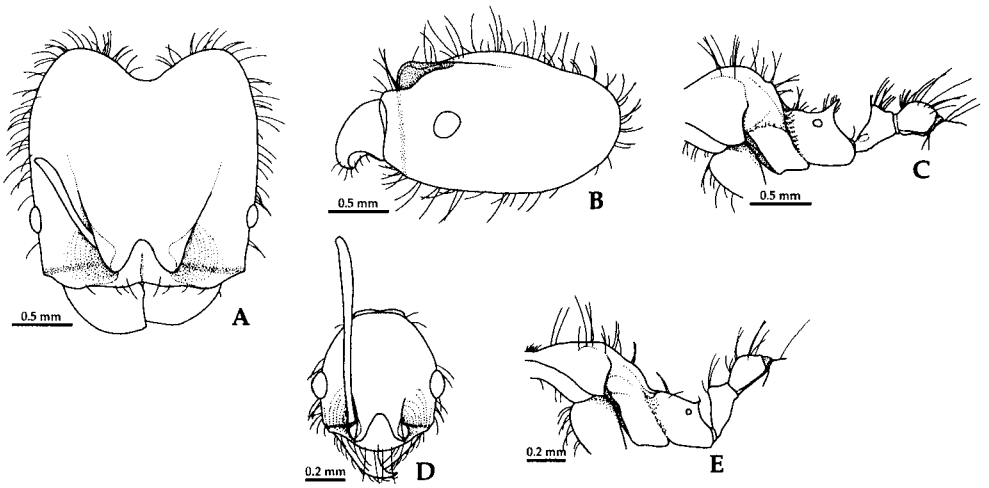

Fig. 49. *Pheidole submonticola* sp. nov. (type material: 243A): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

triangular, ca. 1.5 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.1-1.2 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole in dorsal view subpentagonal, ca. 2.2 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; remainder of alitrunk weakly rugose, with interspaces very weakly punctured but shining; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Head, alitrunk and gaster brown to dark brown; mandibles, antennae, legs and waist light brown.

Recognition This relatively large-sized species with a general habitus is similar to *P. aglae* Forel and *P. cariniceps* sp. nov., but it is peculiar in having a combination of the following conditions: hypostoma of the major completely lacking median processes; propodeal spine of the major elongate-triangular and broadly based (Fig. 49C); posterior declivity of promesonotal dome of the minor without any prominence (Fig. 49C); lower part of mesopleuron margined dorsally in the major.

Distribution Borneo.

Bionomics This species seems to inhabit well-developed premontane / lower montane forests.

49. *Pheidole tawauensis* sp. nov. (Fig. 50)

Holotype Major, soil-9 (soil sample), Tawau Hills Park, Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1996, deposited in UMS.

Paratypes 2 majors and 7 minors from the same soil sample to which the holotype belongs, deposited in BMNH and UMS.

Other specimens examined BORNEO. Sarawak, Malaysia: Lambir Hills N. P., 1 major and 3 minors (Honey bait sample G-3-3), SKY, 1993. JAVA, Indochina. Kebun Raya, Bogor, 2 majors, 3 minors and 1 male (FI95-770); G. Halimun, 1 major, 3 minors and 1 queen (FI98-365).

Major Measurements and indices (n=4): TL 2.5-2.7 mm, HL 1.23-1.28 mm, HW 1.05-1.08 mm, SL 0.47-0.51 mm, FL 0.69-0.77 mm, CI 83-86, SI 44-49, FI 66-73. Head broadest at about midlength

of head (Fig. 50A), in profile not impressed on vertex (Fig. 50B). Hypostoma bearing three median processes, of which medianmost one is inconspicuous. Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye 1.7-2.0 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Frontal lobe relatively developed and erect (Fig. 50B). Antenna with 3-segmented club; scape extending backward to or slightly passing midlength of head; terminal segment 1.0-1.1 times as long as preceding two segments together. Mandible with apical and preapical teeth, and a distinct denticle in front of basal angle. Promesonotum forming a high dome, without any distinct prominence on its posterior declivity (Fig. 50C); each dorsolateral portion of the dome weakly produced. Mesopleuron sometimes divided by a weak transverse impression into two parts, of which lower part is margined dorsally. Propodeal spine triangular, 2-2.5 times as long as diameter of propodeal spiracle. Petiole 1.7-1.9 times as long as postpetiole (excluding helcium); petiolar node in posterior view weakly emarginate at apex. Postpetiole 2.0-2.1 times as broad as petiolar node, in dorsal view strongly angulate laterally.

Frons longitudinally rugose, with enclosures smooth and shining; vertex, and dorsal and lateral faces of occipital lobe weakly rugoso-reticulate, with enclosures weakly punctured and weakly shining; dorsum of promesonotal dome rugose at least partly; anterior and lateral faces of the dome, and lower part of mesopleuron largely smooth and shining; upper part of mesopleuron and large part of lateral face of propodeum weakly punctured and less shining; or whole alitrunk smooth and shining; lateral faces of petiolar pedicel and postpetiole very weakly punctured; dorsa of petiole and postpetiole smooth and shining; first gastral tergite around its articulation with postpetiole weakly punctured. Outer face of mandible sparsely covered with appressed to decumbent hairs, which are 0.03-0.05 mm in length and shorter than distance between piligerous punctures. Body brown to dark brown; antennae and legs lighter than alitrunk.

Minor Measurements and indices (n=5): TL 1.6-1.8 mm, HL 0.48-0.53 mm, HW 0.43-0.47 mm, SL 0.47-0.53 mm, AL 0.67-0.72 mm, FL 0.53-0.58 mm, CI 89-90, SI 107-113, FI 122-124. Head in full-face view almost flat medioposteriorly; occipital carina weak but complete (Fig. 50D). Clypeus without median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 1.0-1.1 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape extending beyond posterior border of head by a little more than its 1/5 length; terminal segment 1.0-1.1 times as long as preceding two segments together. Promesonotum convex, without any prominence on its posterior declivity (Fig. 50E). Mesopleuron occasionally divided by a weak transverse impression into two parts. Metanotal groove in profile deep (Fig. 50E). Propodeal spine almost twice as long as diameter of propodeal spiracle. Petiole 1.7-1.8 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole in dorsal view subhexagonal, 1.8-2.1 times as broad as petiolar node.

Head including clypeus smooth and shining; alitrunk almost smooth and shining; lateral face of petiolar pedicel very weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and

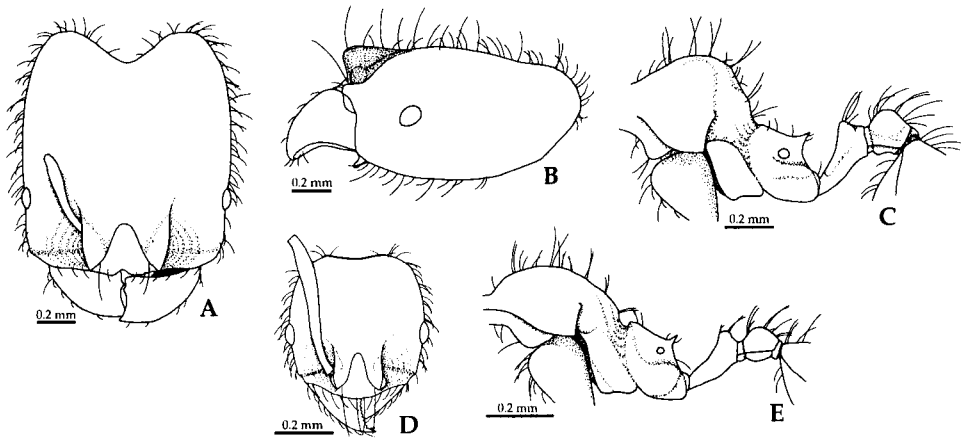

Fig. 50. ***Pheidole tawauensis*** **sp. nov. (type material: soil-9): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

shining. Body yellowish-brown to brown.

Recognition This species is very similar to *P. butteli* Forel among Indo-Chinese and Indo-Malayan congeners (for the difference between the two, see under *P. butteli*).

Distribution Indochina, Borneo and Java.

50. ***Pheidole tenebricosa*** sp. nov. (Fig. 51)

Holotype Major, colony: Eg97-BOR-394, Mt. Kinabalu (near the Headquarter), Sabah, E. Malaysia (Borneo), K. Eguchi leg., 1997, deposited in UMS.

Paratypes 18 majors, 19 minors and 1 queen from the same colony to which the holotype belongs, deposited in BMNH, MBD, MCSN, MCZ, MHNG, MSNM, NHMW and UMS.

Other specimens examined BORNEO. Sabah, Malaysia: Mt. Kinabalu, ca. 1500 m alt., 22 majors, 43 minors and 1 queen (Eg97-BOR-392, 393, 393B, 395, 396, 397, 406, 409) / 10 majors, 14 minors and 15 males (322A, 323A; Eg97-BOR-598), TK / ca. 1800 m alt., 8 majors, 12 minors and 2 males (18Q22S1, 18Q22S2; 564A), TK; Poring, 1530 m alt. (East Ridge), 3 minors (code EW-1, EW-2, EW-2/2), CB, 1995 / 1740 m alt. (East Ridge), 1 minor (code FB-1), CB, 1995 / 1930 m alt. (East Ridge), 2 minors (code GW-1), CB, 1995.

Major Measurements and indices (n=5): TL 2.5-3.0 mm, HL 1.08-1.23 mm, HW 1.00-1.20 mm, SL 0.53-0.64 mm, FL 0.66-0.79 mm, CI 91-97, SI 50-58, FI 63-69. Head broadest at about 2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 51A), in profile weakly impressed on vertex (Fig. 51B). Hypostoma bearing three median processes, of which lateral two are poorly developed. Clypeus occasionally with a weak median longitudinal carina, with anterior margin weakly concave medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.4-1.8 times as long as maximal diameter of eye. Frontal carina horizontal, extending backward to about 2/3 distance of head (Fig. 51A). Antennal scrobe narrowly overhung by frontal carina. Antenna with 3-segmented club; antennal scape extending backward to 3/5-2/3 distance of head; terminal segment ca. 1.2 times as long as preceding two segments together.

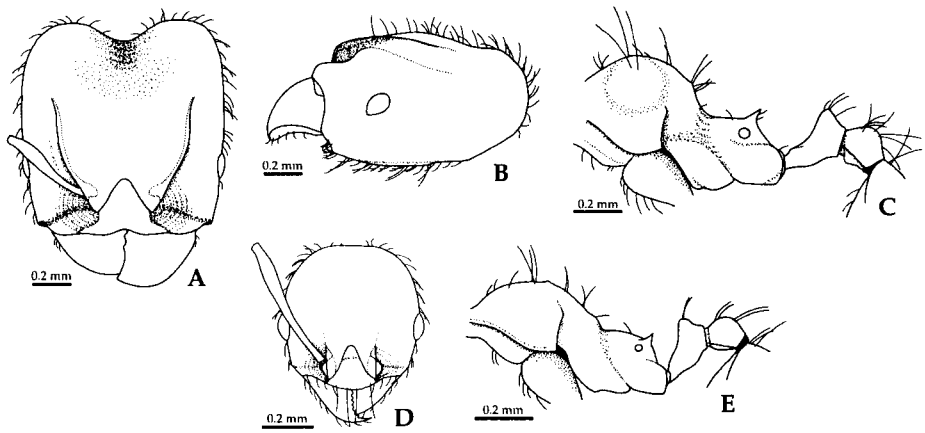

Fig. 51. ***Pheidole tenebricosa*** **sp. nov. (type material: Eg97-BOR-394): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.**

Masticatory margin of mandible with apical and preapical teeth, and two denticles in front of basal angle. Promesonotum forming a high dome, without a distinct prominence on its posterior declivity (Fig. 51C); each dorsolateral portion of the dome usually rather strongly produced outward. Mesopleuron divided by a weak transverse impression. Propodeal spine horn-like, usually blunt apically, almost twice as long as diameter of propodeal spiracle. Petiole 1.6-1.7 times as long as postpetiole (excluding helcium); petiolar node in posterior view not or hardly emarginate at apex. Postpetiole 1.4-1.5 times as broad as petiolar node.

Gena and anterior part of frons longitudinally rugose, with interspaces very weakly punctured and weakly shining; posterior part of frons, vertex, and dorsal and dorsolateral faces of occipital lobe reticulate, with punctured and dull enclosures; area between frontal carina and eye largely punctured and dull; outer face of mandible with rugulae only laterally around its base; dorsum of promesonotal dome coarsely reticulate, with weakly punctured enclosures; lateral face of promesonotum at least partly punctured or rugose; lower part of mesopleuron largely smooth and shining; remainder of alitrunk largely punctured; ventral faces of midcoxa and hindcoxa distinctly reticulate; lateral faces of petiole and postpetiole weakly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining. Outer face of mandible sparsely covered with very short appressed hairs, which are 0.02-0.04 mm in length and much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer decumbent hairs. Body dark brown to blackish-brown; antennae and legs lighter than alitrunk.

Minor Measurements and indices (n=5): TL 1.5-1.8 mm, HL 0.50-0.58 mm, HW 0.46-0.53 mm, SL 0.48-0.58 mm, AL 0.68-0.82 mm, FL 0.49-0.61 mm, CI 91-93, SI 103-109, FI 106-114. Head in full-face view weakly concave posteriorly (Fig. 51D); occipital carina evanescent dorsally on head. Clypeus without a median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 0.9-1.0 times as long as maximal diameter of eye. Frontal carina and antennal

scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior border of head by about its 1/5 length; terminal segment 1.1-1.2 times as long as preceding two segments together. Promesonotal dome with a gentle posterior declivity which has no prominence (Fig. 51E). Mesopleuron without a distinct transverse impression. Propodeal spine 1-1.5 times as long as diameter of propodeal spiracle. Petiole ca. 1.6 times as long as postpetiole (excluding helcium); petiolar node in posterior view not or slightly emarginate at apex. Postpetiole 1.6-1.7 times as broad as petiolar node.

Dorsum of head above subocular level including clypeus punctured, and ventral face below the level smooth and shining; alitrunk punctured; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body colour pattern similar to that of the major.

Recognition *P. tenebricosa* sp. nov. is closely related to *P. maculifrons* Wheeler (known only from Philippines), *P. rugifera* sp. nov., *P. clypeocornis* sp. nov., *P. kikutai* sp. nov. and *P. hortensis* Forel, and they are recognised among the congeners by the characteristics noted under *P. hortensis*. *P. tenebricosa* sp. nov. is very similar to *P. rugifera* sp. nov. among the species known from Borneo, and is distinguished from the latter by the characteristics noted under *P. rugifera* sp. nov.

Distribution Borneo.

Bionomics This species has so far been found from well-developed forests in Mt. Kinabalu (1500-1800 m alt.). It nests in rotting wood on the ground, and occasionally stores up a number of tiny seeds in its nest (Eg97-BOR-393, 396).

51. *Pheidole tjibodana* Forel (Fig. 52)

Pheidole nodgii var. *tjibodana* Forel, 1905: 16, major, minor and queen (MHNG). Type locality: Tjibodas [Cibodas], Java (K. Kraepelin leg.). Revised status as subspecies: Bolton, 1995.

Pheidole tjibodana: Eguchi, 2001 (with lectotype designation and redescription of type material).

Specimens examined BORNEO. Sabah, Malaysia: Danum Valley, 1 minor, CB, 1998-1999; Poring, 560 m alt. (East Ridge), 2 minors (code AW-2, AW-3), CB, 1995 / 600 m alt., 1 major, 3 minors and 1 queen (6XI0106-16-1), TK; Sayap Kinabalu, 2 majors, 2 minors and 1 queen (S-27; LS-2), SKY and KE, 1996; Sepilok forest, 2 majors (GC), SKY, 1995; Tawau Hills Park, 2 majors, 5 minors and 1 queen (Eg96-BOR-031, 039) / 1 major and 2 minors (GC; S-6), SKY, 1996; Gunong Rara, 1 major and 5 minors (Eg97-BOR-565). INDOCHINA. Thailand: Khao Yai N. P., Nakhonratchasima, 3 majors and 5 minors (TH00-SKY-15). JAVA, Indonesia. Cibodas, W. Java, 1 major and 2 minors (10/1a), K. Ohkawara leg., 1999; Mt. Halimun, 1 major, 2 minors and 1 queen (FI98-382); G. Salak, nr. Bogor, W. Java, 4 majors, 26 minors and 1 queen (JA97-SKY-12).

Major Measurements and indices (n=7): TL 1.9-2.4 mm, HL 0.93-1.10 mm, HW 0.92-1.08 mm, SL 0.45-0.54 mm, FL 0.53-0.64 mm, CI 93-100, SI 48-50, FI 57-60. Head with almost parallel sides, or broadest at 3/5-2/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)) (Fig. 52A); head in profile distinctly convex on upper frons; the declivity from the top toward occipital lobe at most very weakly impressed (Fig. 52B). Hypostoma with a large median process (Fig. 52C). Clypeus without a median longitudinal carina, with anterior margin emarginate medially. Eye situated at about 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.7-2.0 times as long as maximal diameter of eye. Frontal carina well developed, horizontal, extending backward to 2/3 distance of head (Fig. 52A). Antennal scrobe extensively overhung by frontal carina. Frontal lobe

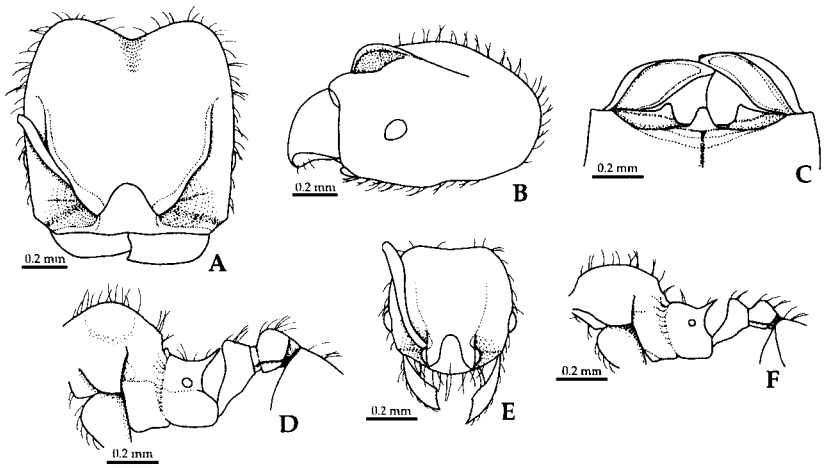

Fig. 52. ***Pheidole tjibodana*** **Forel (Eg96-BOR-039): A, major, head in full-face view; B, same, head in profile; C, same, hypostoma; D, same, alitrunk and waist in profile; E, minor, head in full-face view; F, same, alitrunk and waist in profile.**

well developed and suberect. Antenna with 3-segmented club; scape extending backward to 3/5-2/3 distance of head; terminal segment 1.2-1.3 times as long as preceding two segments together. Masticatory margin of mandible with apical and preapical teeth, and a denticle in front of basal angle. Promesonotal dome with a low prominence on its posterior declivity (Fig. 52D); each dorsolateral portion of the dome weakly produced outward. Mesopleuron without a distinct impression. Propodeal spine horn-like, 3.5-4 times as long as diameter of propodeal spiracle. Petiole 1.8-2.0 times as long as postpetiole (excluding helcium), with a relatively long petiolar peduncle; petiolar node distinct, in posterior view not or slightly emarginate at apex. Postpetiole 1.5-1.8 times as broad as petiole, angulate laterally.

Frons longitudinally rugose, with very weakly punctured interspaces; vertex, and dorsal and dorsolateral faces of occipital lobe reticulate, with enclosures weakly punctured and weakly shining; antennal scrobe punctured and dull; promesonotum weakly reticulate dorsally, with punctured and dull enclosures; lower part of mesopleuron at most partly smooth and shining; declivitous face of propodeum smooth and shining; remainder of alitrunk punctured and dull; lateral faces of petiolar pedicel and postpetiole punctured and dull; dorsa of petiole and postpetiole smooth and shining; first gastral tergite weakly punctured or rugose around its articulation with postpetiole. Outer face of mandible sparsely covered with very short appressed hairs (< 0.03 mm in length), which are much shorter than distance between piligerous punctures; submarginal zone of masticatory margin of mandible with a row of longer appressed to decumbent hairs. Body brown, or dark reddish-brown with lighter head; flagella and legs lighter than alitrunk.

Minor Measurements and indices (n=7): TL 1.4-1.5 mm, HL 0.48-0.53 mm, HW 0.47-0.52 mm, SL 0.40-0.45 mm, AL 0.63-0.67 mm, FL 0.43-0.49 mm, CI 97-102, SI 81-89, FI 88-95. Head in full-face view straight or weakly concave posteriorly (Fig. 52E); occipital carina evanescent dorsally on head. Clypeus with an inconspicuous median longitudinal carina, with anterior margin in full-face view slightly convex medially. Eyes situated just in front of midlength of head; distance between

mandibular insertion and anterior margin of eye 0.7-0.8 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; scape reaching or slightly extending beyond posterior border of head; terminal segment ca. 1.2 times as long as preceding two segments together. Promesonotal dome relatively flat dorsally and with a pair of inconspicuous tubercles dorsolaterally; posterior declivity of the dome very steep or almost vertical, without a prominence (Fig. 52F). Mesopleuron without a transverse impression. Propodeal spine horn-like, straight, 5 times as long as diameter of propodeal spiracle. Petiole 1.8-2.0 times as long as postpetiole (excluding helcium); petiolar node distinct, in posterior view not emarginate at apex. Postpetiole 1.4-1.6 times as broad as petiole.

Dorsal face of head including clypeus and promesonotum weakly reticulate, with enclosures punctured and dull; remainder of head and alitrunk punctured and dull; lateral face of petiole weakly punctured; dorsum of petiole, and postpetiole and gaster smooth and shining. Body brown to dark brown, with lighter gaster; antennae and legs lighter than alitrunk.

Variation Both the subcastes from Eg97-BOR-565 collected at Gunong Rara have short propodeal spines (less than 3 times as long as maximal diameter of propodeal spiracle in the major, and 2-2.5 times in the minor). At present it is difficult to conclude whether relatively short propodeal spine represents a mere variation or any of distinguishing conditions at population level.

Recognition *P. tjibodana* is closely related to *P. nodgii* Forel, *P. magrettii* Emery, *P. retivertex* sp. nov., *P. sayapensis* sp nov. and several undescribed species, and all these are peculiar among Indo-Chinese and Indo-Malayan congeners in the combination of the following characteristics: hypostoma of the major bearing a stout median process (Fig. 52C); frontal carina well developed, horizontal, and extensively overhanging antennal scrobe in the major (Fig. 52A); ventral faces of midcoxa and hindcoxa completely smooth and shining in both the subcastes (contrasted with the condition seen in *P. aristotelis* Forel, and *P. hortensis* Forel and its relatives); head and alitrunk of the minor sculptured. *P. tjibodana* is most closely related to *P. nodgii*, and the diagnostic characters separating the former form the later were noted in Eguchi (2001). *P. tjibodana* is easily distinguished from two Bornean relatives, *P. retivertex* sp. nov. and *P. sayapensis* sp nov., by the characters given in the key.

Distribution Borneo and Java.

Bionomics This species inhabits well-developed lowland and hill forests, and nests in the litter or rotting wood blocks on the ground, and occasionally stores up a number of tiny seeds in its nest (Eg96-BOR-031). I have never encountered colonies which include more than one dealate queen.

52. *Pheidole upeneci* Forel (Fig. 53)

Pheidole (*Elasmopheidole*) *upeneci* Forel, 1913: 43, major and minor (MHNG). Type locality: Cibodas, 4500 feet [ca. 1350 m alt.], Java. Lectotype designation and redescription of type material: Eguchi, 2001.
Pheidole (*Stegopheidole*) *upeneci*: Emery, 1915b: 190.
Pheidole upeneci: Bolton, 1995b: 332.

Specimens examined BORNEO. Sabah, Malaysia: Mahua Waterfall area, 3 majors and 2 minors (Bottle-Eg-A from 15 min. sampling), K. Ogata leg., 2000.

Major Measurements and indices (n=3): TL 2.9-3.3 mm, HL 1.42-1.45 mm, HW 1.20-1.21 mm, SL 0.52-0.55 mm, FL 0.90-0.92, CI 83-85, SI 43-46, FI 74-76. Head broadest just behind midlength of head, broadly concave posteriorly (Fig. 53A); dorsal outline of head in profile steeply sloping from

the posterior border of vertex; occipital lobe in profile triangularly produced (Fig. 53B). Hypostoma bearing three median processes. Clypeus without a median longitudinal carina, with anterior margin very weakly emarginate medially. Eye situated at about 1/3 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points, respectively (cf. Fig. 2A)); distance between mandibular insertion and anterior margin of eye 2.1-2.3 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion and frontal lobe. Frontal lobe suberect, extremely developed, extending beyond anterior clypeal margin (Fig. 53A, B). Masticatory margin of mandible with apical and preapical teeth, and a distinct denticle in front of basal angle. Antenna with 3-segmented club; scape reaching just in front of midlength of head; terminal segment almost as long as preceding two segments together. Promesonotal dome without a prominence on its posterior declivity (Fig. 53C); each dorsolateral portion of the dome weakly produced outward. Mesopleuron without a conspicuous transverse furrow. Propodeal spine horn-like, ca. 3.5 times as long as diameter of propodeal spiracle. Petiole ca. 1.2 times as long as postpetiole (excluding helcium); petiolar node in posterior view weakly or hardly concave at apex. Postpetiole 2.7-3.0 times as broad as petiolar node, produced laterally.

Frons and gena longitudinally rugose, with smooth and shining interspaces; vertex and lateral face of occipital lobe rugoso-reticulate, with enclosures almost smooth and shining; dorsum of occipital lobe almost transversely rugose, with interspaces almost smooth and shining; promesonotum smooth and shining; remainder of alitrunk very weakly punctured, or mesopleuron smooth and shining; petiole weakly punctured laterally, and smooth and shining dorsally; anterodorsal face of postpetiole transversely rugose, and remainder of postpetiole largely smooth and shining; gaster (excluding rugose area around the articulation with postpetiole) smooth and shining. Outer face of mandible covered with long decumbent hairs, which are 0.10-0.18 mm in length and much longer than distance between piligerous punctures. Body brown to dark-brown, with lighter lateral face of alitrunk; antennae and legs lighter than lateral face of alitrunk.

Minor Measurements and indices (n=2): TL 1.8-1.9 mm, HL 0.58-0.60 mm, HW 0.54-0.55 mm, SL 0.59-0.60 mm, AL 0.80-0.82 mm, FL 0.66-0.69 mm, CI 92-93, SI 109, FI 123-126. Head in full-face view suboval, but truncate medioposteriorly (Fig. 53D); occipital carina distinct. Clypeus without a median longitudinal carina, with anterior margin slightly convex medially. Eye situated just in front of midlength of head; distance between mandibular insertion and anterior margin of eye 1.1-1.2 times as long as maximal diameter of eye. Frontal carina and antennal scrobe present only around antennal insertion. Antenna with 3-segmented club; in full-face view scape extending beyond posterior margin of head by its 1/5-1/4 length; terminal segment 0.9-1.0 times as long as preceding two segments together. Promesonotal dome without any prominence on its posterior declivity (Fig. 53E). Mesopleuron with an inconspicuous transverse impression. Propodeal spine horn-like, ca. 2-2.5 times as long as diameter of propodeal spiracle. Petiole ca. 1.2 times as long as postpetiole (excluding helcium); petiolar node in posterior view not emarginate at apex. Postpetiole in dorsal view subhexagonal, 2.0-2.3 times as broad as petiolar node.

Head including clypeus and promesonotum smooth and shining; lower part of mesopleuron, and declivitous face and part of lateral face of propodeum weakly punctured; remainder of alitrunk smooth and shining; lateral face of petiole very weakly punctured; dorsum of petiole, and postpetiole and

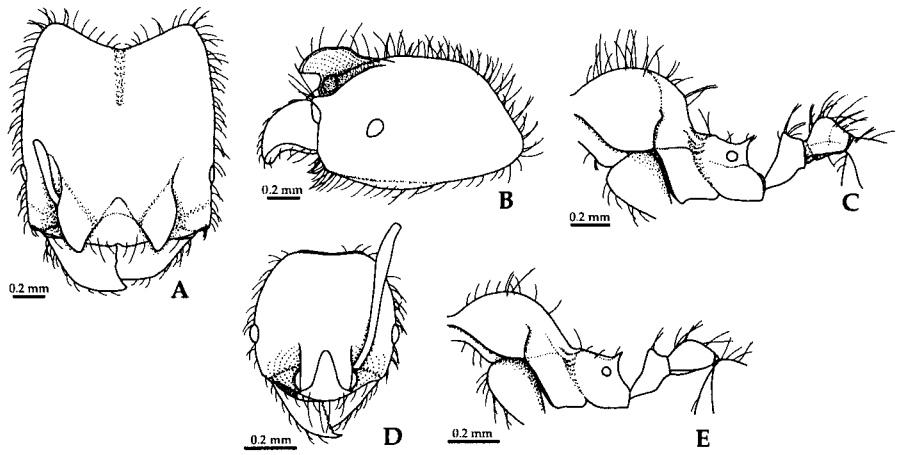

Fig. 53. *Pheidole upeneci* Forel (Bottle-Eg-A, K. Ogata leg.): A, major, head in full-face view; B, same, head in profile; C, same, alitrunk and waist in profile; D, minor, head in full-face view; E, same, alitrunk and waist in profile.

gaster smooth and shining. Body light brown.

Variation The type material from Java is somewhat different from Bornean specimens: in the former frontal lobe of the major almost horizontal; occipital lobe of the major in profile more rounded posteriorly; posterior declivity of promesonotal dome with an inconspicuous prominence in both the subcastes; petiole smaller in both the subcastes (postpetiole ca. 2.0 times as broad as petiolar node) (see also Eguchi, 2001). This suggests the possibility of the presence of local populations defined by a series of morphological characteristics.

Recognition This species is easily distinguished among Indo-Malayan congeners by having extremely developed frontal lobe in the major (Fig. 53A, B).

Distribution Borneo and Java.

Bionomics This species seems to inhabit well-developed hill forests.

BIOGEOGRAPHICAL PATTERNS IN INDO-MALAYAN *PHEIDOLE*

The Indo-Malayan subregion is defined as the area consisting of the southern Malay Peninsula, Borneo, Sumatra, Java, Bali, Philippines, and small islets associated with these main islands; and the Indo-Chinese subregion as the area consisting of the southern part of China, Taiwan, Indochina, Burma, Assam and Gangetic Plain (Lincoln *et al.*, 1998, Appendix 4). Species unknown from Borneo but Southeast Asia are included, and unpublished information of their ranges is utilised in the following discussion.

Similarity among *Pheidole* faunas of some intensively studied areas within the Indo-Malayan subregion

Within the Indo-Malayan subregion, *Pheidole* fauna is relatively well known in the northern part of Borneo, and in lowlands of the southern Malay Peninsula and West Java, and can be compared among these regions. Collection sites covered with well-developed forests are classified into:

1) Lowland areas (up to 600 m alt.) in the northern part of Borneo (LNB; cf. Kobayashi & Hotta, 1978), represented by Belalong Forest Section, Danum Valley, Deramakot, Gunong Rara, Lambir N. P., Merimbun Heritage Park, Poring Hot Spring area, Sepilok forest, and Tawau Hills Park;
2) Lower montane areas (from 1800 m down to 900 m alt.) in the northern part of Borneo (MNB; cf. Kobayashi & Hotta, 1978), represented by Kinabalu Park Headquarters area, Mahua Waterfall area, Poring Hot Spring area, Ranau, and Sayap Kinabalu;
3) Lowland areas in the southern Malay Peninsula (LSMP), represented by Ulu Gombak; and
4) Lowland areas in W. Java (LWJ), represented by Bogor Botanic Garden, Pangandaran and Ujung Kulon. Bogor Botanic Garden is completely artificial, but, according to Ito *et al.* (2001), retains much of the original ant fauna of W. Javanese lowlands.

Fifty-six species (including many undescribed species) are considered in total, and 34 species are in LNB, 30 in MNB, 23 in LSMP and 16 in LWJ, respectively (Table 1; I omit *P. bugi*, *P. fervens* and

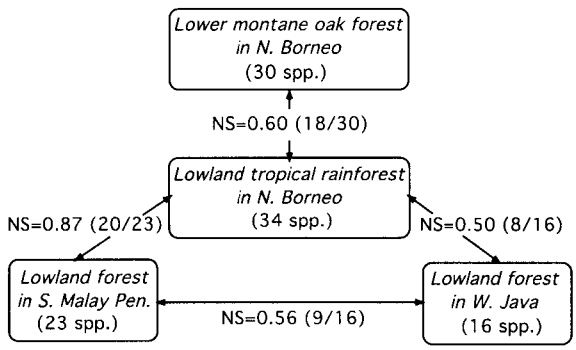

Fig. 54. Similarity of *Pheidole* species compositions among lowland N. Borneo (LNB), lower montane N. Borneo (MNB), lowland S. Malay Peninsula (LSMP) and lowland W. Java (LWJ).

Table 1. ***Pheidole*** **faunas in lowland N. Borneo. lower montane N. Borneo, lowland S. Malay Peninsula and lowland W. Java.**

	LNB	MNB	LSMP	LWJ
acantha		○		
aglae	○	○	○	○
angulicollis	○	○		
annexus	○		○	
aristotelis	○	○	○	○
bluntschlii			○	
butteli	○	○	○	○
cariniceps	○	○	○	
clypeocornis	○	○	○	
comata	○	○		
deltea	○	○		
elisae	○		○	○
fantasia	○	○		
ghigii	○			
gombakensis	○		○	
havilandi		○	○	
hortensis	○	○	○	○
huberi	○		○	
inornata		○		
kikutai		○		
lokitae		○		
longipes	○	○	○	
lucioccipitalis	○	○	○	
merimbun	○			
modiglianii	○		○	
montana		○		
nodgii				○
orophila		○		
parvicorpus	○			
plagiaria	○		○	○
plinii	○			
poringensis	○			
quadrensis	○	○		
quadricuspis	○		○	
quinata		○		
rabo	○		○	
retivertex	○		○	
rugifera	○		○	
sabalna	○	○		
sarawakana	○	○	○	○
sauberi	○	○	○	○
sayapensis		○		
spinicornis	○	○		
submonticola		○		
tandjongensis				○
tawauensis	○			○
tenebricosa		○		
tjibodana	○	○		
upeneci		○		
sp. eg-57				○
sp. eg-75				○
sp. eg-77				○
sp. eg-92				○
sp. eg-96				○
sp. eg-97			○	
total	34	30	23	16

P. bugi, P. fervens and *P. megacephala* are omitted, because all of them have become widespread at least partly in association with human activities.

P. megacephala, all of which have become widespread at least partly in association with human activities, and commonly occur around buildings of the headquarters of national parks). Nomura-Simpson indices (NS=number of species common to both areas / number of species at the least species-rich of the two areas) indicate that in *Pheidole* the faunal similarity between LNB and MNB (NS=0.60) is much lower than that between LNB and LSMP (NS=0.87) (Fig. 54). A low similarity in ground-dwelling forest ants between lowlands and mountain areas has also been observed in W. Java (Ito *et al.*, 2001). The great majority of *Pheidole* species are associated with the forest floor, reflecting both nesting and foraging habits (this study; Brown, 2000, Table 5.1; *Pheidole*, *Strumigenys* and *Hypoponera* were found to be the most speciose genera in the litter of dipterocarp hill forest in Poring Hot Spring area, while in other observed strata, *i.e.*, lower vegetation and canopy, these were not among the speciose genera (Brühl *et al.*, 1998)). Thus the species composition of *Pheidole* and other ground-dwelling ants appears to be influenced by environmental factors (both physical and biotic) at ground level associated with altitude as well as geology, as discussed below. Subsequent faunal divergence between lowland and premontane / lower montane zones might help explain "mid-

elevation peak in species-richness in tropics" suggested by Ward (2000).

The similarity between LNB and LSMP (NS=0.87) is higher than that between LNB and LWJ (NS=0.56) and between LSMP and LWJ (NS=0.50) (Fig. 54). This, together with the lower species richness in LWJ, highlights the unique and distinctive *Pheidole* fauna of W. Javanese lowland rainforest. This faunal dissimilarity probably reflects a decrease in the number of rainforest species in Java and the disjunctive occurrence of Indo-Chinese components (species adapted to seasonal forests), resulting from the Quaternary biogeographical background mentioned below.

Biogeographical background of the present-day Indo-Chinese and Indo-Malayan *Pheidole* faunas

A number of rough distributional patterns among the *Pheidole* species from Southeast Asia are recognised. The species for which available distributional or ecological data are limited are omitted from discussion. Due to the nearly complete absence of phylogenetic information on the species of this genus, the discussions that follow are limited in scope and somewhat speculative. However, recognised distributional patterns are to some extent explainable using recent analyses of the Quaternary environmental changes in this area (Brandon-Jones, 1998; Kaars & Dam, 1995; Whitten *et al.*, 1996). The patterns are as follows:

1) Wide-ranging in East and Southeast Asia, or pantropical, in association with human activities (represented by *P. bugi*, *P. fervens* and *P. megacephala*)

These species are widely distributed in Southeast Asia or even pantropical, and inhabit open land to forest edges. Their distribution seems to have been partly affected by recent human activities, through their immigration into man-made habitats or transportation by human commerces.

2) Occurring on both sides of Wallace's Line (represented by *P. aglae* (Fig. 55) and *P. plagiaria* (Fig. 56))

P. aglae is distributed in the Indo-Malayan subregion and New Guinea, and inhabits well-developed forests (primary and well-recovered secondary forests) in lowlands and hill areas. *P. plagiaria* is widespread in the Indo-Chinese and Indo-Malayan subregions, and also known from Sulawesi (Viehmeyer, 1916b) and Batjan (Smith, 1860) near Molucca, within the Austro-Malayan subregion. It usually inhabits well-developed lowland forests in at least Borneo (see under bionomics of *P. plagiaria*). I have not yet recognised distinct signs of geographical variation in morphology over its range. "The subgenus *Pheidolacanthinus* (*sensu* Emery, 1921)" also occurs in both the Indo-Malayan and Indo-Australian subregions. I collected one undetermined species from W. New Guinea which undoubtedly has a close relationship with *P. quadricuspis* and its allies, the Indo-Malayan representative of "*Pheidolacanthinus*". Brown (1973) suggests rafting as a possible mean of long-distance overseas transport of tropical ants nesting in pre-formed plant cavities, such as hollow twigs, hollow nuts and leaf bases. According to Brandon-Jones (1998), rafts are likely to have been much more frequent during the post-glacial period of vegetational succession in Southeast Asia. At least distributional patterns across Wallace's Line were brought about by such dispersal because there were probably no direct land connections between the two sides during the Quarternary falls in the sea level.

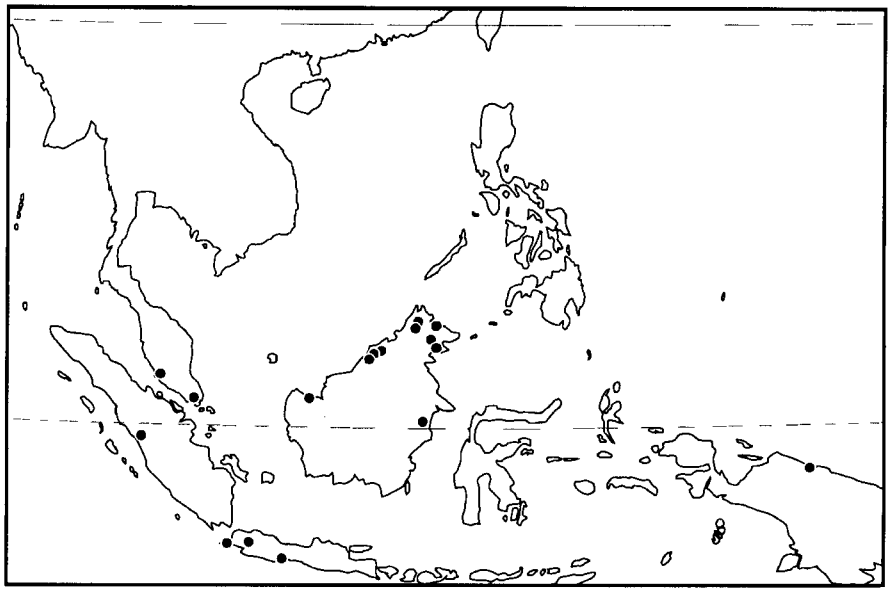

Fig. 55. Distribution of *P. aglae* Forel.

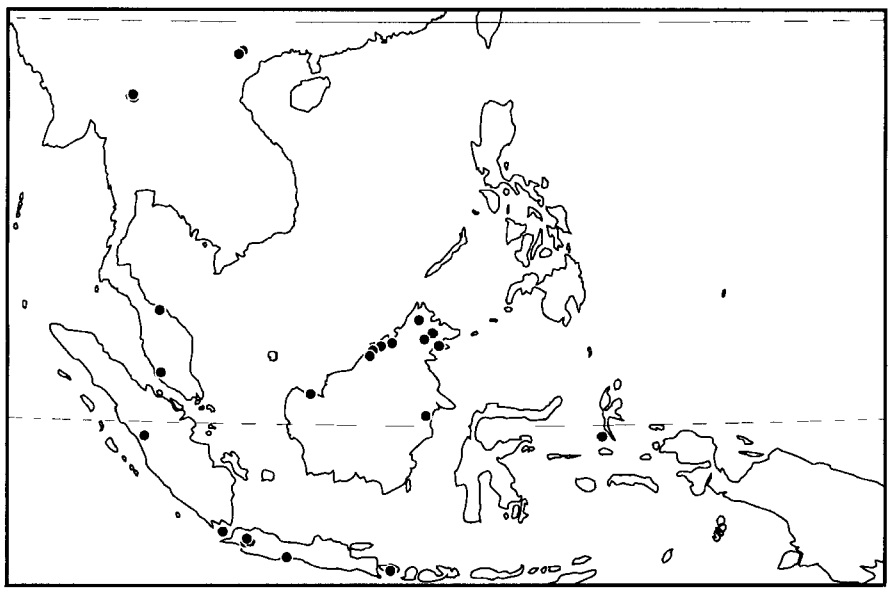

Fig. 56. Distribution of *P. plagiaria* Fr. Smith. *P. p. retilineata* was described from Sulawesi (Viehmeyer, 1916b) without a mention of the precise type locality.

3) Indo-Chinese and Indo-Malayan (represented by *P. longipes* and *P. tjibodana*)

P. longipes is distributed in the Indo-Chinese and Indo-Malayan subregions, and found in forest habitats (including seasonal forests in Indochina as well as true tropical rainforests). Previous authors recognised several "subspecies" in *P. longipes*: nominal plus *conicollis* from Sumatra (Emery, 1900), *continentis* from Burma (Forel, 1911a), *pseudola* from Sumatra (Forel, 1915). However, the exact

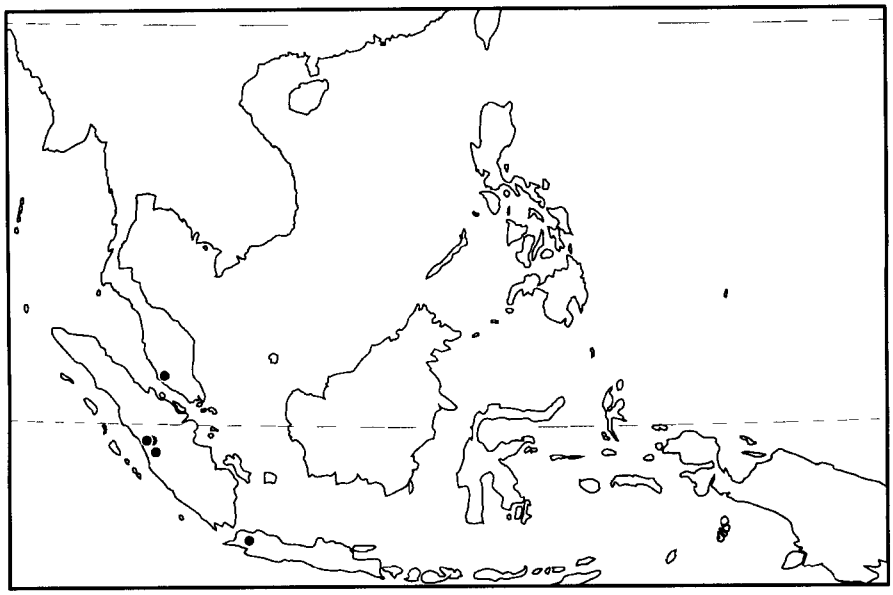

Fig. 57. Distribution of *P. bluntschlii* Forel.

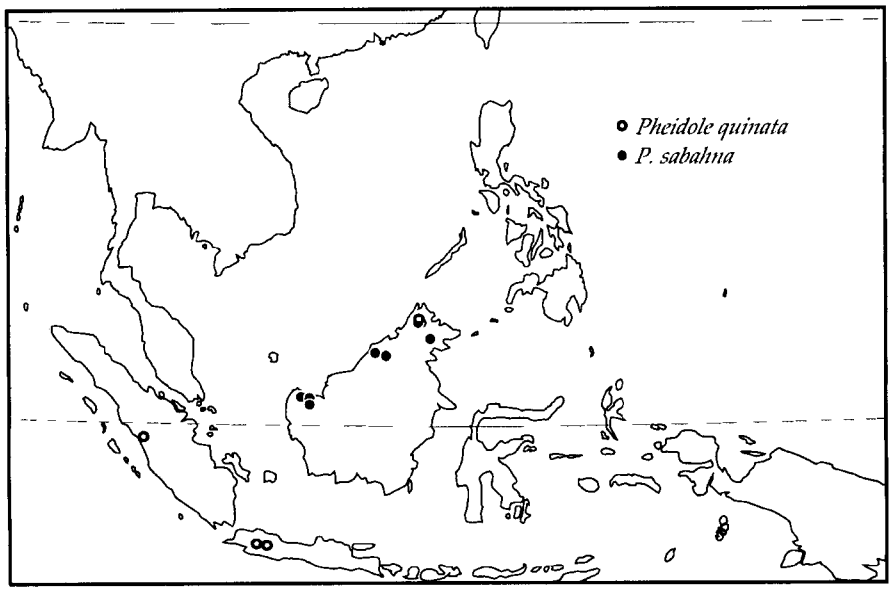

Fig. 58. Distribution of *P. quinata* Eguchi and *P. sabahna* Eguchi.

status of these forms has not been fully resolved. I now feel the need to revise this group in detail based on molecular and morphological data. I have tentatively recognised a *P. smythiesii* group which consists of Emery's "espèces de l'Inde" of "the genus *Ceratopheidole*" (Emery, 1922), *i.e.*, *P. smythiesii* (widespread in the Indo-Chinese subregion) and its subsp. *bengalensis* (Bengal), *P. bhavanae* (Sikkim), *P. emmae* (Java) and *P. bluntschlii* (S. Malay Peninsula, Sumatra and Java; Fig. 57). I include in this group *P. gatesi*, which is widespread in the Indo-Chinese subregion, and was

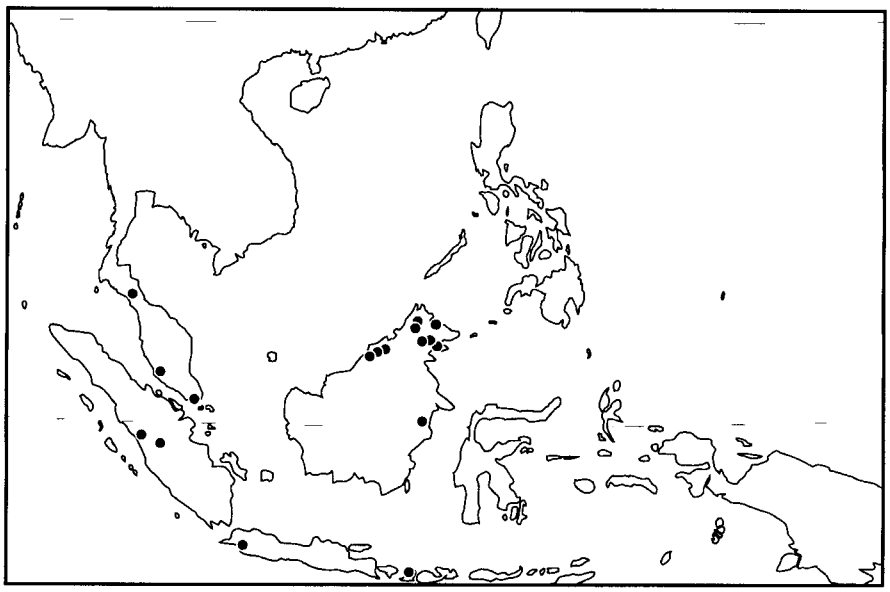

Fig. 59. Distribution of *P. aristotelis* Forel.

originally described under *Aphaenogaster* by Wheeler (1927a), then transferred to *Pheidole* by Brown (1967). The group is characterised by a 4-segmented antennal club, but its monophyly has not yet been established. It is Indo-Chinese and Indo-Malayan in distribution, but interestingly no species occurs in Borneo. Examinations of available specimens, including type materials, of the above-mentioned forms, excluding *P. emmae* (of which the type material has apparently been lost), suggest that *P. bluntschlii* is an atypical member in the group and characterised by a combination of the following characteristics: anterior margin of clypeus of the minor emarginate medially in full-face view; hypostoma of the major unarmed medially; low subpetiolar process present in the major; radial cell of the male wing completely closed. *P. bluntschlii* is very similar to species of the *P. quinata* group in its general features, except in the segmentation of antennal club and the condition of processes on hypostoma of the major. The male of *P. sabahna*, belonging to the *P. quinata* group, also has a completely closed radial cell (cf. Eguchi, 2000), a condition not common in Asian species of *Pheidole* as far as I know. Thus there is a possibility that the *P. quinata* group is phylogenetically closest to *P. bluntschlii*, and is the Bornean representative (Fig. 58) of the *P. smythiesii* group in a wide sense. Anyway, a careful phylogenetic reconstruction is required for members of the *P. smythiesii* group and *P. quinata* group (and also *P. granulata* group, namely, "espèces Américaines" of "*Ceratopheidole*" (Emery, 1922)) prior to detailed biogeographical analysis.

4) Inhabitants of Indo-Malayan rainforests

4.1) Indo-Malayan (represented by *P. aristotelis* (Fig. 59), *P. butteli*, *P. clypeocornis* sp. nov., *P. deltea* sp. nov., *P. elisae*, *P. hortensis*, *P. sarawakana* and *P. sauberi*)

These species occur in the southern Malay Peninsula (with the exception of *P. deltea* sp. nov.), Borneo, Sumatra, Java, and in one case the Philippines (*P. sauberi*). They inhabit well-developed forests from lowlands to hill areas.

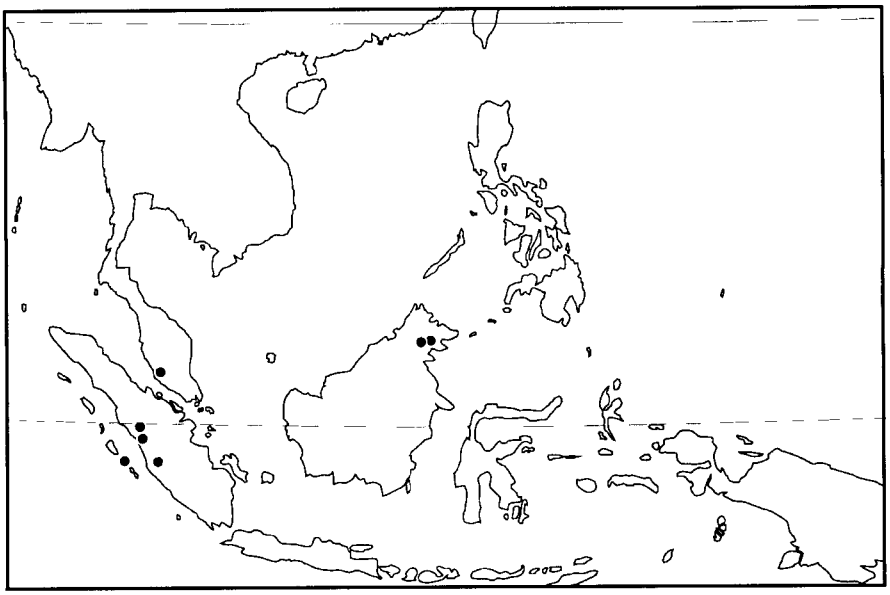

Fig. 60. Distribution of *P. modiglianii* Emery.

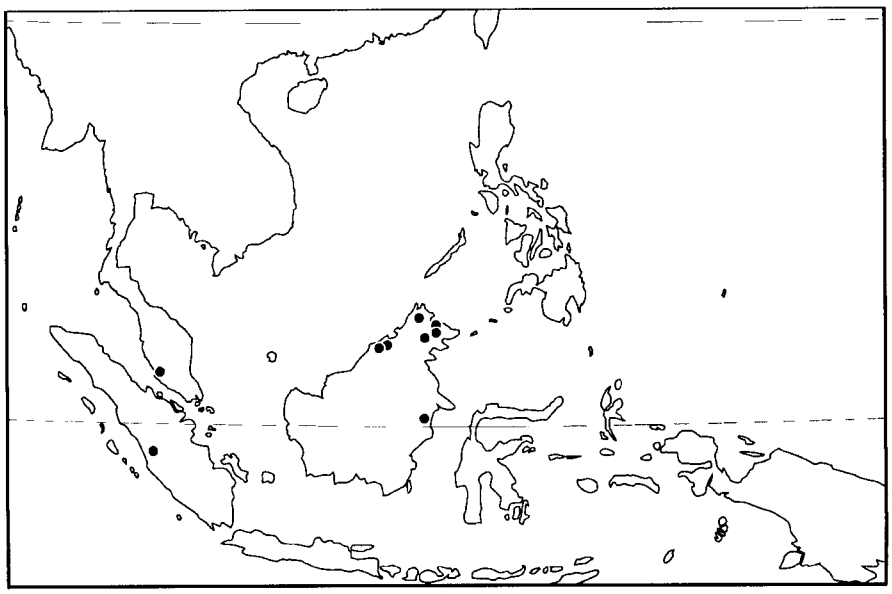

Fig. 61. Distribution of *P. quadricuspis* Emery.

4.2) Covering the Sunda Shelf area excluding Java (represented by *P. annexus* sp. nov., *P. cariniceps* sp. nov., *P. gombakensis* sp. nov., *P. havilandi*, *P. huberi*, *P. lucioccipitalis* sp. nov., *P. modiglianii* (Fig. 60), *P. quadrensis*, *P. quadricuspis* (Fig. 61), *P. rabo*, *P. retivertex* sp. nov. and *P. rugifera* sp. nov.).

These species occur in the southern Malay Peninsula (with the exception of *P. quadrensis*), Borneo and Sumatra (with the exception of *P. huberi*, *P. rabo* and *P. gombakensis* sp. nov.), but are not found on

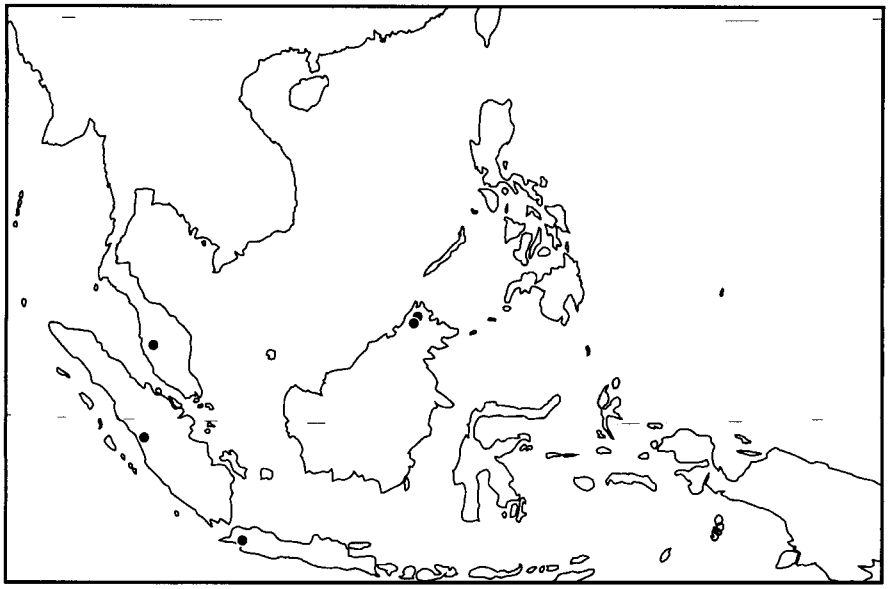

Fig. 62. Distribution of *P. orophila* sp. nov.

Java. They also inhabit well-developed forests from lowlands to hill areas. The northern limit of the species belonging to these two subsets (4.1 & 4.2) almost agrees with the line Alor Star-Singgora which is one of the three principal floristic demarcation knots defining the Malesian region (Steenis, 1950). Inger (1996) made a similar observation in Amphibia: "the sharpest relative drop in numbers of Malaysian species takes place between 10° and 12°N and the sharpest drop in Indochinese species at 12°-14°N". The larger part of western Java, the southern Malay Peninsula, Borneo and Sumatra constitute a large ever-wet belt, while the remainder of Java, the western part of the Philippines, the southern part of Sulawesi and the Lesser Sunda Islands are under a monsoon climate (Steenis, 1979). Moving eastward along Java annual rainfall decreases and the cycle of wet and dry seasons becomes more distinct, and even in the western part of Java, characterised by typical features of the humid tropics, actual monthly rainfall in particular years is often far below the dry season threshold (Nakamura *et al.*, 1994). The presence or absence of a species in Java is probably subject to the influence of climate. This partly contributes to the lower faunal similarity between lowland rainforest in W. Java and that in Borneo, and between W. Java and the southern Malay Peninsula as mentioned above. Agosti *et al.* (1999) mentioned that the genus *Cladomyrma* seems to be restricted in its distribution to the ever-wet area comprising the Malay Peninsula, Borneo and Sumatra, but no records exist from Java with its drier climate. However, each species is further restricted in a certain area within the whole range of the genus (with an exception of *C. maschwitzi* Agosti and *C. crypteroniae* Agosti *et al.*).

5) Premontane / lower montane on more than one island in the Indo-Malayan subregion
(represented by *P. comata*, *P. orophila* sp. nov. (Fig. 62) and *P. upeneci* Forel)

P. comata is disjunctively distributed in the premontane / lower montane zone in the southern Malay Peninsula and Borneo (but rarely collected in lowlands, *e.g.*, Poring Hot Spring area, ca. 600 m alt.),

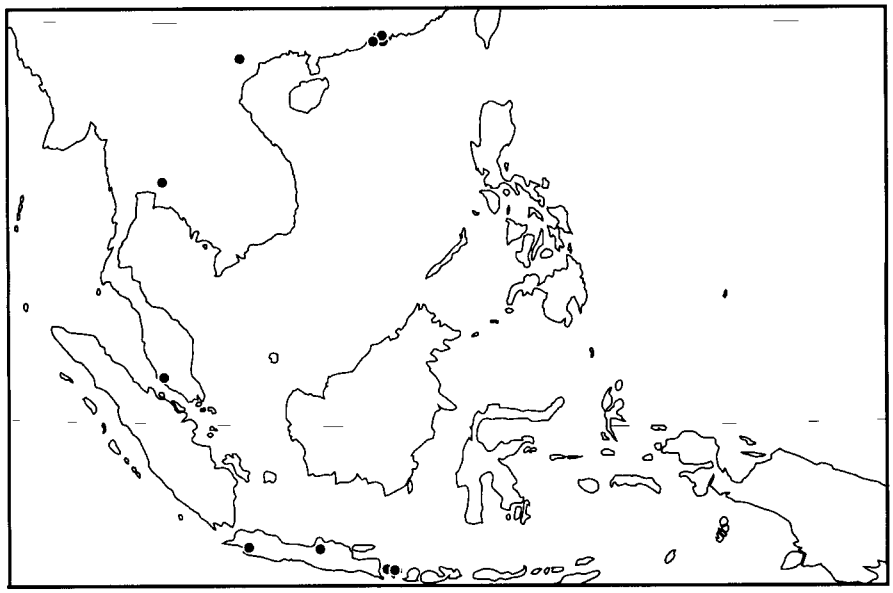

Fig. 63. Distribution of *P. spathifera* Forel group.

P. upeneci in Borneo and Java, and *P. orophila* sp. nov. in the southern Malay Peninsula, Borneo, Sumatra and Java. They can be considered relicts which ranged more widely during the glacial periods, at times of downward expansion of premontane / lower montane vegetation due to lowered temperature (Kaars & Dam, 1995).

6) **Indo-Chinese, with conspecific isolated populations in Java or Java+Bali** (represented by *P. noda*, *P.* sp. eg-75 (? *P. platifrons*), *P. tandjongensis*, and the *P. spathifera* group (Fig. 63), of which the number of species is larger on the continent and only one lineage, *P.* sp. eg-57, is confined to Java and Bali)

These species are widely distributed in the Indo-Chinese subregion and its adjacent areas and have conspecific or closely related population / taxa disjunctively in Java or Java+Bali (*P. tandjongensis* also occurring in Sumatra). They appear to prefer seasonal forests to rainforests. Similar cases are observed in plants: some significant spermatophyte genera, known from Java but absent from Sumatra and Borneo, occur mostly in the monsoon forests of Burma, Thailand and Indochina (Johns, 1995). As mentioned above, Java, especially its eastern part, is now under seasonal climate. Furthermore the Indo-Malayan subregion probably experienced lower humidity and greater seasonal variations in temperature during Pleistocene glacial periods, and the seasonal forests would have been more extensive than now (Kaars & Dam, 1995; Whitten *et al.*, 1996). Thus ancestral lineages of the species with this geographic pattern probably immigrated from the Southeast Asian mainland into the Indo-Malayan subregion, and became more widespread with expansion of seasonal forests during extensive exposure of the Sunda Shelf during the glacial periods. Present populations in Java might have been left there by post-glacial recovery of lowland rainforests after the last glacial maximum. The *Lophomyrmex quadrispinosus* (Jerdon) group (Rigato, 1994) may, if its monophyly is supported, be categorised in the same pattern, because *L. opaciceps* Viehmeyer, a member of the group, is found

only from Java, whereas the other members, *L. birmanus* Emery, *L. kali* Rigato and *L. quadrispinosus*, are found from the Oriental region excluding the Indo-Malayan subregion. The *Pheidologeton yanoi* Forel group, similarly, is present in Indochina and Java, but absent in Borneo and Sumatra (Yamane, 2001, pers. com.). This also contributes to the lower faunal similarity between lowland rainforest in W. Java and that in Borneo / southern Malay Peninsula.

7) Restricted to Borneo

7.1) Species inhabiting lower montane oak forest (represented by *P. acantha* sp. nov., *P. kikutai* sp. nov., *P. montana*, *P. sayapensis* sp. nov., *P. submonticola* sp. nov. and *P. tenebricosa* sp. nov.)

These species have so far been found from Borneo and inhabit lower montane oak forests. They may have been derived, through habitat shift, from populations which originally inhabited lowland rainforests; or they have originated from isolated populations of premontane / lower montane species which were once widespread during glacial periods, and they have still remained confined to Borneo probably due to their lower dispersal abilities and / or scant dispersal opportunities. These species, together with the species of Pattern 5, constitute a unique *Pheidole* fauna of lower montane oak forest in N. Borneo.

7.2) Lowland tropical rainforest species (represented by *P. merimbun* sp. nov., *P. parvicorpus* sp. nov., *P. poringensis* sp. nov.).

These species, together with *P. sabahna* (Fig. 58), *P. spinicornis* sp. nov. and *P. angulicollis* sp. nov. inhabiting both lowland rainforests and lower montane oak forests, may have originated through isolations caused by glacial environmental changes (mentioned below), and they have still remained confined to Borneo probably due to their lower dispersal abilities and / or scant dispersal opportunities (initial cases of Pattern 4).

Speciation in the Indo-Malayan subregion

Based on his analysis of the present and fossil distributions of ants, Brown (1973) suggested that warm-country dominant ant taxa, such as *Pheidole* and *Crematogaster*, probably originated in tropical Africa-southern Asia and have spread explosively over the rest of the earth from about the Miocene, and that *Tetramorium*, which arose almost simultaneously, and *Camponotus*, which arose earlier in the Tertiary, may also fit this pattern in a general way.

Relatively high diversity in the Indo-Malayan subregion of *Pheidole* and of several other groups, *e.g.*, *Camponotus* which are adapted to humid tropical habitats (Yamane, 2001, pers. com.), may have been caused partly by repeated immigrations from the continents (Pattern 6, and probably part of Pattern 5). Speciation within the subregion may also have contributed to it to a large extent. The Pleistocene refuge theory proposed by Brandon-Jones (1998) presents one possible explanation for *Pheidole* speciation in the Indo-Malayan subregion. According to this theory the multiplication of species adapted to lowland rainforests in the subregion would have been caused by repeated shrinkage and fragmentation of Indo-Malayan lowland rainforests during glacial periods and the resultant occurrence of a number of isolated populations of which some became new species. This may also be principally true for the multiplication of species adapted to premontane / lower montane forest, but here isolation events were associated with interglacial periods (mentioned above). On the other hand, species newly emerged through peripatric / allopatric speciation would have tended to spread widely

in area possessing suitable habitat after they become partly or completely free from barriers. Thus the species number (diversity at species level) in a certain area would have further increased.

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江口克之　ボルネオ産オオズアリ属の再検討（昆虫綱，膜翅目，アリ科，フタフシアリ亜科）

オオズアリ属（昆虫綱，膜翅目，アリ科）は熱帯および亜熱帯の森林の林床部において優占的なアリの一群である。この論文において，東南アジア熱帯に位置し世界で3番目に大きな島であるボルネオ島に生息する本属の種を分類類学的に再検討した。23新種を含む以下の52種がボルネオ島から確認された：*Pheidole acantha* 新種, *P. aglae* Forel, *P. angulicollis* 新種, *P. annexus* 新種, *P. aristotelis* Forel, *P. bugi* Wheeler, *P. butteli* Forel, *P. cariniceps* 新種, *P. cingulata* (Fr. Smith), *P. clypeocornis* 新種, *P. comata* Fr. Smith, *P. deltea* 新種, *P. elisae* Emery, *P. fantasia* Chapman, *P. fervens* Fr. Smith, *P. ghigii* Emery, *P. gombakensis* 新種, *P. havilandi* Forel, *P. hortensis* Forel, *P. huberi* Forel, *P. inornata* 新種, *P. kikutai* 新種, *P. lokitae* Forel, *P. longipes* (Fr. Smith), *P. lucioccipitalis* 新種, *P. manukana* 新種, *P. megacephala* (Fabricius), *P. merimbun* 新種, *P. modiglianii* Emery, *P. montana* Eguchi, *P. orophila* 新種, *P. parvicorpus* 新種, *P. plagiaria* Fr. Smith, *P. planidorsum* 新種, *P. plinii* Forel, *P. poringensis* 新種, *P. quadrensis* Forel, *P. quadricuspis* Emery, *P. quinata* Eguchi, *P. rabo* Forel, *P. retivertex* 新種, *P. rugifera* 新種, *P. sabahna* Eguchi, *P. sarawakana* Forel, *P. sauberi* Forel, *P. sayapensis* 新種, *P. spinicornis* 新種, *P. submonticola* 新種, *P. tawauensis* 新種, *P. tenebricosa* 新種, *P. tjibodana* Forel, *P. upeneci* Forel. *P. bugi*, *P. fantasia*および*P. javana* var. *desucta* Wheelerについてレクトタイプが指定された。*P. elisae* var. *nenia* Forel, 1913は*P. elisae* Emery, 1900の，そして*P. javana* var. *desucta* Wheeler, 1929は*P. fervens* Fr. Smith, 1858のジュニアシノニムであると確認された。大型ワーカー，小型ワーカー，大型および小型ワーカーに基づく種の検索表を提示した。大半の種について分布および生態情報を示した。最後にインド-シナ亜区およびインド-マレー亜区におけるオオズアリ相に見られるいくつかの特徴について生物地理学的な観点から解釈を試みた。

Appendix I. Species names and Eguchi's personal species codes for Bornean *Pheidole*

1	*acantha* sp. nov.	sp. eg-13	sp. eg-1	*plagiaria* Fr. Smith
2	*aglae* Forel	sp. eg-9	sp. eg-2	*retivertex* sp. nov.
3	*angulicollis* sp. nov.	sp. eg-118	sp. eg-3	*quadrensis* Forel
4	*annexus* sp. nov.	sp. eg-4	sp. eg-4	*annexus* sp. nov.
5	*aristotelis* Forel	sp. eg-6	sp. eg-5	*quadricuspis* Emery
6	*bugi* Wheeler	sp. eg-56	sp. eg-6	*aristotelis* Forel
7	*butteli* Forel	sp. eg-22	sp. eg-7	*sayapensis* sp. nov.
8	*cariniceps* sp. nov.	sp. eg-25	sp. eg-8	*tjibodana* Forel
9	*cingulata* (Fr. Smith)	-	sp. eg-9	*aglae* Forel
10	*clypeocornis* sp. nov.	sp. eg-30	sp. eg-10	*hortensis* Forel
11	*comata* Fr. Smith	sp. eg-32	sp. eg-11	*sauberi* Forel
12	*deltea* sp. nov.	sp. eg-15, 24	sp. eg-12	*lucioccipitalis* sp. nov.
13	*elisae* Emery	sp. eg-42	sp. eg-13	*acantha* sp. nov.
14	*fantasia* Chapman	sp. eg-46	sp. eg-14	*modiglianii* Emery
15	*fervens* Fr. Smith	sp. eg-17	sp. eg-15	*deltea* sp. nov.
16	*ghigii* Emery	sp. eg-36	sp. eg-16	*quinata* Eguchi
17	*gombakensis* sp. nov.	sp. eg-108	sp. eg-17	*fervens* Fr. Smith
18	*havilandi* Forel	sp. eg-37	sp. eg-18	*megacephala* (Fabricius)
19	*hortensis* Forel	sp. eg-10	sp. eg-19	*parvicorpus* sp. nov.
20	*huberi* Forel	sp. eg-34	sp. eg-20	*inornata* sp. nov.
21	*inornata* sp. nov.	sp. eg-20	sp. eg-21	*planidorsum* sp. nov.
22	*kikutai* sp. nov.	sp. eg-43	sp. eg-22	*butteli* Forel
23	*lokitae* Forel	sp. eg-84	sp. eg-23	*montana* Eguchi
24	*longipes* (Fr. Smith)	sp. eg-31	sp. eg-24	*deltea* sp. nov.
25	*lucioccipitalis* sp. nov.	sp. eg-12	sp. eg-25	*cariniceps* sp. nov.
26	*manukana* sp. nov.	sp. eg-35	sp. eg-26	*rabo* Forel
27	*megacephala* (Fabricius)	sp. eg-18	sp. eg-28	*sarawakana* Forel
28	*merimbun* sp. nov.	sp. eg-81	sp. eg-29	*tenebricosa* sp. nov.
29	*modiglianii* Emery	sp. eg-14	sp. eg-30	*clypeocornis* sp. nov.
30	*montana* Eguchi	sp. eg-23	sp. eg-31	*longipes* (Fr. Smith)
31	*orophila* sp. nov.	sp. eg-47	sp. eg-32	*comata* Fr. Smith
32	*parvicorpus* sp. nov.	sp. eg-19	sp. eg-34	*huberi* Forel
33	*plagiaria* Fr. Smith	sp. eg-1	sp. eg-35	*manukana* sp. nov.
34	*planidorsum* sp. nov.	sp. eg-21	sp. eg-36	*ghigii* Emery
35	*plinii* Forel	sp. eg-82	sp. eg-37	*havilandi* Forel
36	*poringensis* sp. nov.	sp. eg-45	sp. eg-38	*spinicornis* sp. nov.
37	*quadrensis* Forel	sp. eg-3	sp. eg-41	*tawauensis* sp. nov.
38	*quadricuspis* Emery	sp. eg-5	sp. eg-42	*elisae* Emery
39	*quinata* Eguchi	sp. eg-16	sp. eg-43	*kikutai* sp. nov.
40	*rabo* Forel	sp. eg-26	sp. eg-45	*poringensis* sp. nov.
41	*retivertex* sp. nov.	sp. eg-2	sp. eg-46	*fantasia* Chapman
42	*rugifera* sp. nov.	sp. eg-63	sp. eg-47	*orophila* sp. nov.
43	*sabahna* Eguchi	sp. eg-49	sp. eg-48	*submonticola* sp. nov.
44	*sarawakana* Forel	sp. eg-28	sp. eg-49	*sabahna* Eguchi
45	*sauberi* Forel	sp. eg-11	sp. eg-56	*bugi* Wheeler
46	*sayapensis* sp. nov.	sp. eg-7	sp. eg-63	*rugifera* sp. nov.
47	*spinicornis* sp. nov.	sp. eg-38	sp. eg-81	*merimbun* sp. nov.
48	*submonticola* sp. nov.	sp. eg-48	sp. eg-82	*plinii* Forel
49	*tawauensis* sp. nov.	sp. eg-41	sp. eg-84	*lokitae* Forel
50	*tenebricosa* sp. nov.	sp. eg-29	sp. eg-108	*gombakensis* sp. nov.
51	*tjibodana* Forel	sp. eg-8	sp. eg-118	*angulicollis* sp. nov.
52	*upeneci* Forel	-	-	*cingulata* (Fr. Smith)
			-	*upeneci* Forel

Appendix II. List of colonies examined

A numeral in brackets indicates the species to which a given colony belongs. Numerals and corresponding species names are: **[1]** *P. acantha* sp. nov.; **[2]** *P. aglae* Forel; **[3]** *P. angulicollis* sp. nov.; **[4]** *P. annexus* sp. nov.; **[5]** *P. aristotelis* Forel; **[6]** *P. bugi* Wheeler; **[7]** *P. butteli* Forel; **[8]** *P. cariniceps* sp. nov.; **[9]** *P. cingulata* (Fr. Smith); **[10]** *P. clypeocornis* sp. nov.; **[11]** *P. comata* Fr. Smith; **[12]** *P. deltea* sp. nov.; **[13]** *P. elisae* Emery; **[14]** *P. fantasia* Chapman; **[15]** *P. fervens* Fr. Smith; **[16]** *P. ghigii* Emery; **[17]** *P. gombakensis* sp. nov.; **[18]** *P. havilandi* Forel; **[19]** *P. hortensis* Forel; **[20]** *P. huberi* Forel; **[21]** *P. inornata* sp. nov.; **[22]** *P. kikutai* sp. nov.; **[23]** *P. lokitae* Forel; **[24]** *P. longipes* Fr. Smith; **[25]** *P. lucioccipitalis* sp. nov.; **[26]** *P. manukana* sp. nov.; **[27]** *P. megacephala* (Fabricius); **[28]** *P. merimbun* sp. nov.; **[29]** *P. modiglianii* Emery; **[30]** *P. montana* Eguchi; **[31]** *P. orophila* sp. nov.; **[32]** *P. parvicorpus* sp. nov.; **[33]** *P. plagiaria* Fr. Smith; **[34]** *P. planidorsum* sp. nov.; **[35]** *P. plinii* Forel; **[36]** *P. poringensis* sp. nov.; **[37]** *P. quadrensis* Forel; **[38]** *P. quadricuspis* Emery; **[39]** *P. quinata* Eguchi; **[40]** *P. rabo* Forel; **[41]** *P. retivertex* sp. nov.; **[42]** *P. rugifera* sp. nov.; **[43]** *P. sabahna* Eguchi; **[44]** *P. sarawakana* Forel; **[45]** *P. sauberi* Forel; **[46]** *P. sayapensis* sp. nov.; **[47]** *P. spinicornis* sp. nov.; **[48]** *P. submonticola* sp. nov.; **[49]** *P. tawauensis* sp. nov.; **[50]** *P. tenebricosa* sp. nov.; **[51]** *P. tjibodana* Forel; **[52]** *P. upeneci* Forel.

KE's colony collection

(Eg)96-JPN-001 **[15]**; (Eg)96-JPN-003 **[15]**; Eg00-BOR-100 **[3]**; Eg00-BOR-101 **[11]**; Eg00-BOR-102 **[23]**; Eg00-BOR-113 **[31]**; Eg00-BOR-116 **[12]**; Eg00-BOR-119 **[12]**; Eg00-BOR-121 **[2]**; Eg00-BOR-125 **[12]**; Eg00-BOR-126 **[2]**; Eg00-BOR-128 **[12]**; Eg00-BOR-129 **[37]**; Eg00-BOR-130 **[10]**; Eg00-WM-001 **[31]**; Eg00-WM-002 **[31]**; Eg96-BOR-006 **[45]**; Eg96-BOR-008 **[2]**; Eg96-BOR-009 **[15]**; Eg96-BOR-010 **[5]**; Eg96-BOR-011 **[19]**; Eg96-BOR-015 **[12]**; Eg96-BOR-020 **[45]**; Eg96-BOR-021 **[15]**; Eg96-BOR-022 **[2]**; Eg96-BOR-023 **[4]**; Eg96-BOR-026 **[2]**; Eg96-BOR-031 **[51]**; Eg96-BOR-033 **[2]**; Eg96-BOR-034 **[37]**; Eg96-BOR-036 **[19]**; Eg96-BOR-038 **[2]**; Eg96-BOR-039 **[51]**; Eg96-BOR-040 **[12]**; Eg96-BOR-045 **[19]**; Eg96-BOR-046 **[45]**; Eg96-BOR-050 **[19]**; Eg96-BOR-052 **[21]**; Eg96-BOR-058 **[11]**; Eg96-BOR-060 **[21]**; Eg96-BOR-061 **[2]**; Eg96-BOR-062 **[19]**; Eg96-BOR-063 **[19]**; Eg96-BOR-064 **[21]**; Eg96-BOR-068 **[2]**; Eg96-BOR-069 **[45]**; Eg96-BOR-070 **[19]**; Eg96-BOR-090 **[34]**; Eg96-BOR-095 **[19]**; Eg96-BOR-102 **[45]**; Eg96-BOR-104 **[7]**; Eg96-BOR-105 **[19]**; Eg96-BOR-106 **[19]**; Eg96-BOR-108 **[27]**; Eg96-BOR-110 **[5]**; Eg96-BOR-111 **[25]**; Eg96-BOR-115 **[45]**; Eg96-BOR-116 **[19]**; Eg96-BOR-117 **[25]**; Eg96-BOR-124 **[25]**; Eg96-BOR-129 **[4]**; Eg96-BOR-132 **[25]**; Eg96-BOR-136 **[10]**; Eg96-BOR-141B **[5]**; Eg96-BOR-141C **[5]**; Eg96-BOR-142 **[5]**; Eg96-BOR-143 **[5]**; Eg96-BOR-144 **[5]**; Eg96-BOR-145 **[25]**; Eg96-BOR-146 **[10]**; Eg96-BOR-161 **[10]**; Eg96-BOR-164 **[44]**; Eg96-BOR-165 **[2]**; Eg96-BOR-166 **[25]**; Eg96-BOR-168 **[10]**; Eg96-BOR-170 **[4]**; Eg96-BOR-171 **[44]**; Eg96-BOR-172 **[44]**; Eg96-BOR-176 **[10]**; Eg96-BOR-180 **[10]**; Eg96-BOR-187 **[5]**; Eg96-BOR-188 **[25]**; Eg96-BOR-189 **[12]**; Eg96-BOR-190 **[10]**; Eg96-BOR-191 **[5]**; Eg96-BOR-196 **[10]**; Eg96-BOR-197 **[5]**; Eg96-BOR-198 **[5]**; Eg96-BOR-205 **[5]**; Eg96-BOR-207 **[25]**; Eg96-BOR-208 **[10]**; Eg96-BOR-209 **[10]**; Eg96-BOR-210 **[45]**; Eg96-BOR-211 **[25]**; Eg96-BOR-220 **[25]**; Eg96-BOR-221 **[5]**; Eg96-BOR-222 **[10]**; Eg96-BOR-228 **[5]**; Eg96-BOR-229 **[2]**; Eg96-BOR-230 **[10]**; Eg96-BOR-231 **[44]**; Eg96-BOR-233 **[10]**; Eg96-BOR-234 **[5]**; Eg96-BOR-235 **[5]**; Eg96-BOR-236 **[10]**; Eg96-BOR-247 **[44]**; Eg96-BOR-248 **[4]**; Eg96-BOR-264 **[10]**; Eg96-BOR-265 **[24]**; Eg96-BOR-266 **[2]**; Eg96-BOR-267 **[25]**; Eg96-BOR-271 **[33]**; Eg96-BOR-273 **[5]**; Eg96-BOR-274 **[10]**; Eg96-BOR-275 **[10]**; Eg96-BOR-278 **[10]**; Eg96-BOR-279 **[37]**; Eg96-BOR-283 **[19]**; Eg96-BOR-287 **[13]**; Eg96-BOR-292 **[25]**; Eg96-BOR-293 **[25]**; Eg96-BOR-294 **[33]**; Eg96-BOR-302 **[45]**; Eg96-BOR-303 **[10]**; Eg96-BOR-304 **[5]**; Eg96-BOR-305 **[19]**; Eg96-BOR-306 **[29]**; Eg96-BOR-312 **[5]**; Eg96-BOR-315 **[38]**; Eg96-BOR-316 **[19]**; Eg96-BOR-317 **[5]**; Eg96-BOR-319 **[38]**; Eg96-BOR-320 **[38]**; Eg96-BOR-328 **[37]**; Eg96-BOR-329 **[10]**; Eg96-BOR-339 **[12]**; Eg96-BOR-343A **[38]**; Eg96-BOR-343B **[38]**; Eg96-BOR-344 **[10]**; Eg96-BOR-345 **[10]**; Eg96-BOR-347 **[10]**; Eg96-BOR-351 **[33]**; Eg96-BOR-353 **[38]**; Eg96-BOR-354 **[10]**; Eg96-BOR-355 **[19]**; Eg96-BOR-356 **[10]**; Eg96-BOR-363 **[33]**; Eg96-BOR-365 **[19]**; Eg96-BOR-366 **[19]**; Eg96-BOR-370 **[38]**; Eg96-BOR-372 **[38]**; Eg96-BOR-373 **[10]**; Eg96-BOR-374 **[12]**.

Eg97-BOR-376 **[27]**; Eg97-BOR-377 **[1]**; Eg97-BOR-378 **[19]**; Eg97-BOR-379 **[19]**; Eg97-BOR-386 **[1]**; Eg97-BOR-387 **[30]**; Eg97-BOR-392 **[50]**; Eg97-BOR-393 **[50]**; Eg97-BOR-393B **[50]**; Eg97-BOR-394 **[50]**;

Eg97-BOR-395 [50]; Eg97-BOR-396 [50]; Eg97-BOR-397 [50]; Eg97-BOR-404 [1]; Eg97-BOR-406 [50]; Eg97-BOR-407 [30]; Eg97-BOR-409 [50]; Eg97-BOR-411 [41]; Eg97-BOR-411B [41]; Eg97-BOR-411C [41]; Eg97-BOR-412 [33]; Eg97-BOR-415 [45]; Eg97-BOR-416 [2]; Eg97-BOR-418 [33]; Eg97-BOR-419 [4]; Eg97-BOR-420 [8]; Eg97-BOR-422 [2]; Eg97-BOR-423 [4]; Eg97-BOR-425 [45]; Eg97-BOR-427 [10]; Eg97-BOR-433 [41]; Eg97-BOR-438 [19]; Eg97-BOR-440 [10]; Eg97-BOR-442 [10]; Eg97-BOR-443 [19]; Eg97-BOR-444 [19]; Eg97-BOR-445 [5]; Eg97-BOR-446 [10]; Eg97-BOR-448 [19]; Eg97-BOR-450 [10]; Eg97-BOR-452 [45]; Eg97-BOR-455 [5]; Eg97-BOR-456 [5]; Eg97-BOR-460 [33]; Eg97-BOR-461 [19]; Eg97-BOR-463 [2]; Eg97-BOR-464 [33]; Eg97-BOR-465 [2]; Eg97-BOR-466 [2]; Eg97-BOR-467 [4]; Eg97-BOR-469 [19]; Eg97-BOR-470 [19]; Eg97-BOR-471 [37]; Eg97-BOR-472 [4]; Eg97-BOR-477 [41]; Eg97-BOR-480 [5]; Eg97-BOR-483 [4]; Eg97-BOR-485 [45]; Eg97-BOR-487 [45]; Eg97-BOR-488 [19]; Eg97-BOR-494 [19]; Eg97-BOR-495 [38]; Eg97-BOR-496 [41]; Eg97-BOR-497 [41]; Eg97-BOR-498 [41]; Eg97-BOR-499 [5]; Eg97-BOR-502 [45]; Eg97-BOR-511 [5]; Eg97-BOR-513 [45]; Eg97-BOR-524 [7]; Eg97-BOR-526 [33]; Eg97-BOR-530 [38]; Eg97-BOR-534 [33]; Eg97-BOR-535 [37]; Eg97-BOR-536 [5]; Eg97-BOR-542 [37]; Eg97-BOR-556 [33]; Eg97-BOR-557 [38]; Eg97-BOR-558 [38]; Eg97-BOR-565 [51]; Eg97-BOR-566 [33]; Eg97-BOR-571 [37]; Eg97-BOR-572 [45]; Eg97-BOR-578 [41]; Eg97-BOR-584 [32]; Eg97-BOR-585 [32]; Eg97-BOR-588 [40].

Eg98-BOR-051 [46]; Eg98-BOR-801 [8]; Eg98-BOR-802 [42]; Eg98-BOR-803 [33]; Eg98-BOR-805 [2]; Eg98-BOR-806 [37]; Eg98-BOR-807 [2]; Eg98-BOR-808 [33]; Eg98-BOR-813 [42]; Eg98-BOR-815 [24]; Eg98-BOR-817 [33]; Eg98-BOR-818 [33]; Eg98-BOR-819 [33]; Eg98-BOR-821 [5]; Eg98-BOR-822 [37]; Eg98-BOR-825 [33]; Eg98-BOR-829 [33]; Eg98-BOR-830 [7]; Eg98-BOR-836 [42]; Eg98-BOR-839 [43]; Eg98-BOR-840 [8]; Eg98-BOR-846 [30]; Eg98-BOR-847 [30]; Eg98-BOR-849 [18]; Eg98-BOR-850 [43]; Eg98-BOR-855 [43]; Eg98-BOR-860 [19]; Eg98-BOR-862 [19]; Eg98-BOR-863 [2]; Eg98-BOR-865 [41]; Eg98-BOR-870 [37]; Eg98-BOR-871 [33]; Eg98-BOR-874 [4]; Eg98-BOR-875 [41]; Eg98-BOR-876 [37]; Eg98-BOR-879 [24]; Eg98-BOR-880 [47]; Eg98-BOR-882 [5]; Eg98-BOR-883 [19]; Eg98-IRI-674 [27]; Eg98-IRI-675 [27]; Eg98-IRI-676 [27]; Eg98-IRI-703 [27]; Eg98-IRI-704 [2]; Eg98-IRI-706 [2]; Eg98-IRI-714 [2]; Eg98-LMB-1020 [6]; Eg98-LMB-1021 [6]; Eg98-LMB-1048 [10]; Eg98-LMB-1065 [10]; Eg98-LMB-1066 [10]; Eg98-LMB-1067 [10].

Eg99-BOR-004 [6]; Eg99-BOR-006 [10]; Eg99-BOR-007 [33]; Eg99-BOR-008 [33]; Eg99-BOR-028 [33]; Eg99-BOR-030 [33]; Eg99-BOR-035 [33]; Eg99-BOR-036 [10]; Eg99-BOR-039 [38]; Eg99-BOR-047 [35]; Eg99-BOR-049 [8]; Eg99-BOR-050 [8]; Eg99-BOR-052 [37]; Eg99-BOR-055 [35]; Eg99-BOR-063 [8]; Eg99-BOR-070 [33]; Eg99-BOR-073 [13]; Eg99-BOR-074 [33]; Eg99-BOR-077 [13]; Eg99-BOR-085 [7]; Eg99-BOR-086 [28]; Eg99-BOR-090 [10]; Eg99-BOR-094 [10]; Eg99-BOR-106 [10]; Eg99-BOR-109 [10]; Eg99-BOR-111 [38]; Eg99-BOR-112 [38]; Eg99-BOR-115 [5]; Eg99-BOR-117 [5]; Eg99-BOR-119 [10]; Eg99-BOR-123 [33]; Eg99-BOR-124 [10]; Eg99-BOR-133 [8]; Eg99-BOR-135 [8]; Eg99-BOR-137 [8]; Eg99-BOR-138 [5]; Eg99-BOR-141 [5]; Eg99-BOR-150 [33]; Eg99-BOR-151 [5]; Eg99-BOR-154 [2]; Eg99-BOR-200 [24]; Eg99-BOR-203 [13]; Eg99-BOR-205 [5]; Eg99-BOR-207 [25]; Eg99-BOR-209 [5]; Eg99-BOR-213 [13]; Eg99-BOR-216 [24]; Eg99-BOR-217 [37]; Eg99-BOR-218 [8]; Eg99-BOR-220 [25]; Eg99-BOR-222 [38]; Eg99-BOR-223 [25]; Eg99-BOR-226 [24]; Eg99-BOR-233 [19]; Eg99-BOR-235 [25]; Eg99-BOR-503 [33]; Eg99-BOR-508 [5]; Eg99-BOR-513 [10]; Eg99-BOR-514 [19]; Eg99-BOR-522 [38]; Eg99-BOR-535 [37]; Eg99-BOR-552 [33]; Eg99-BOR-556 [33]; Eg99-BOR-561 [8]; Eg99-BOR-562 [8]; Eg99-BOR-567 [33]; Eg99-BOR-568 [33]; Eg99-BOR-574 [19]; Eg99-BOR-578 [19]; Eg99-BOR-579 [8]; Eg99-BOR-585 [38]; Eg99-BOR-592 [10]; Eg99-BOR-596 [10]; Eg99-BOR-597 [10]; Eg99-BOR-601 [19]; Eg99-BOR-604 [19]; Eg99-BOR-607 [4]; Eg99-BOR-610 [10]; Eg99-VN-001 [33]; Eg99-VN-005 [33]; Eg99-VN-008 [33]; Eg99-VN-009 [33]; Eg99-VN-037 [33]; Eg99-VN-038 [33]; Eg99-VN-052 [33]; Eg99-VN-119 [33].

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